Electronics & Technology Today

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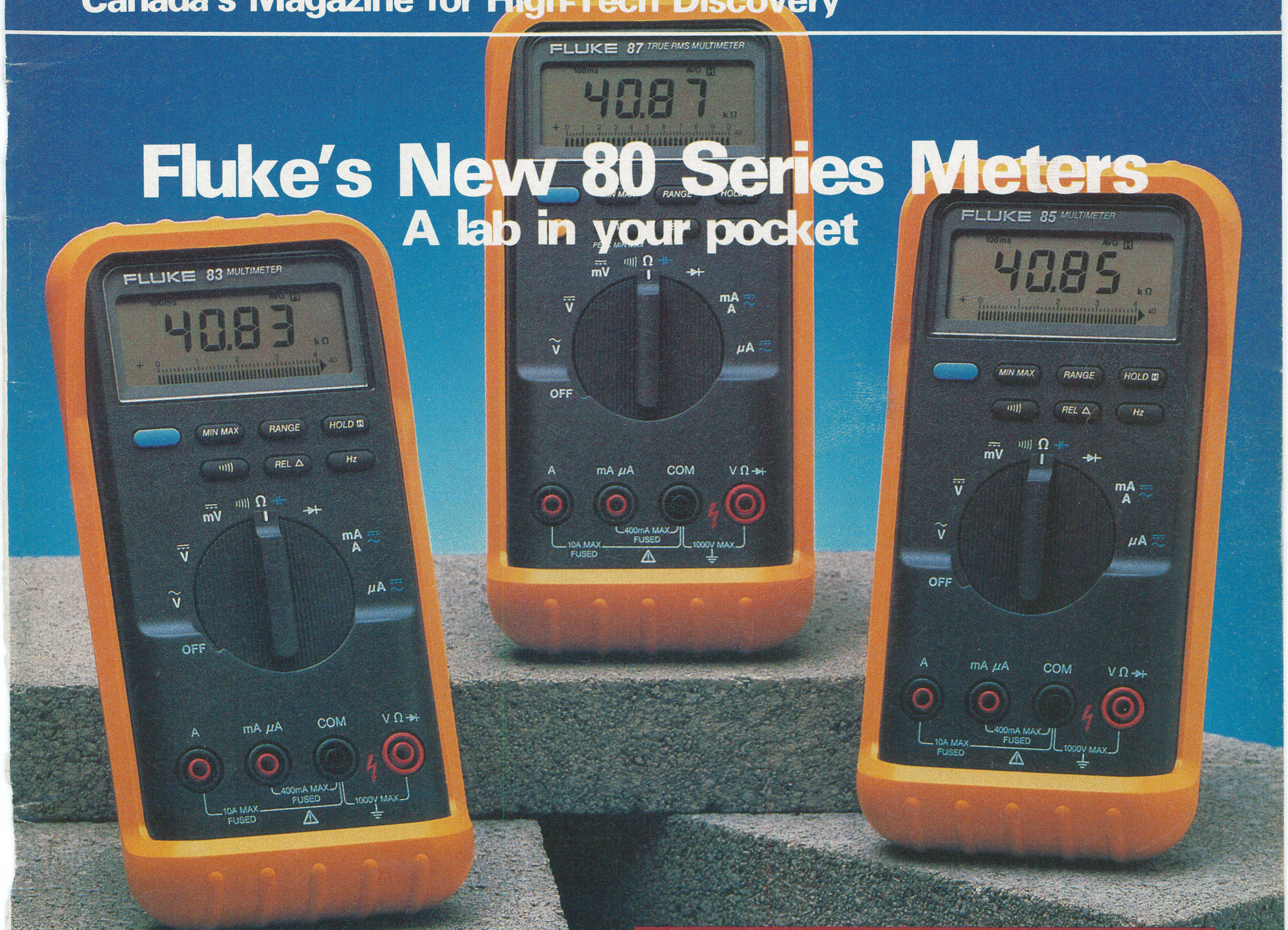

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Electronics & Technology Today

Canada's Magazine for High-tech Discovery

Volume 12, Number 11 **November 1988**

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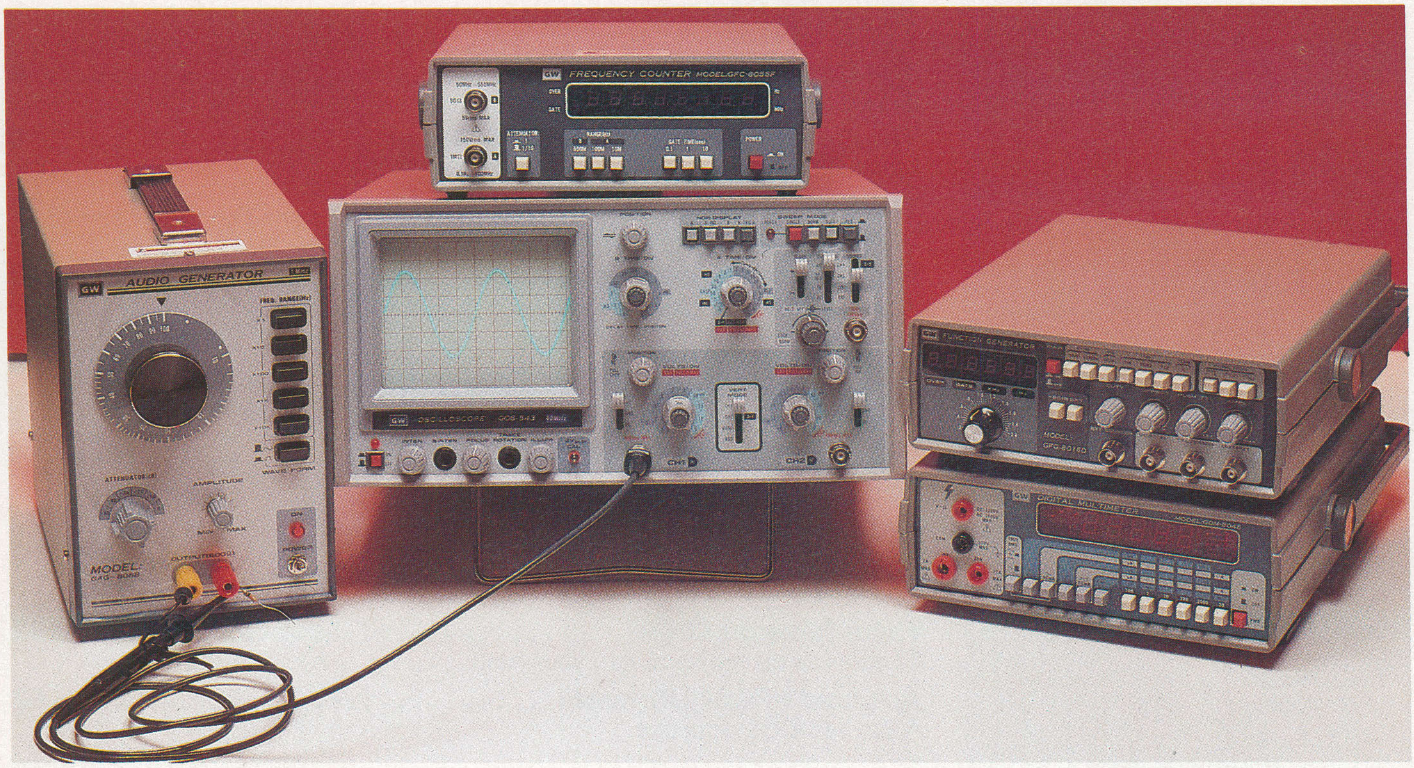
R E V I E W

The Basic Testbench

Ideas on setting up and using basic test equipment.

BILL MARKWICK



One day, when you feel like working on that weekend electronic project, you'll reach into your toolbox for your trusty multimeter and the monkey wrench that was sitting on top of it will have cracked the face. Then you try to measure the millivolt output of your breadboard and the needle moves a hair: is it the meter or the project? Well, you could lash up a one- transistor gain stage to beef up the meter sensitivity, but that could take a while, and you're getting further and further from troubleshooting your project...

It's time to start investing in some good test equipment. Not only will you be able to complete that project, and the six others in the back of the closet, but your learning will take a quantum leap because you'll be able to see and measure the waveforms that were a concealed mystery until now.

You don't have to spend a year's rent, (though that would be nice) and you don't really need all that much room. Silence any objections by saying that appliance repair brings in $100 an hour. When they remind you about the toaster that you said you'd fix six months ago, put on your hat and coat and start shopping for equipment. Here's a rough guide on what to look for.

We'd especially like to thank Duncan Instruments for supplying us with a whole carload of instruments for this article.

The Scope

It has been said many times, usually by me, that the oscilloscope is the heart of the testbench. Sometimes I've called it a workhorse. The whole idea of these lame metaphors is to emphasize that the scope can do almost everything: not only can it measure voltage, current, frequency and a whole lot more, but it lets you see exactly what's going on — whether the signal is full of distortion, or has DC mixed in, or whether the circuit is so unstable that the mere presence of the scope lead triggers oscillations. One screenful is worth a thousand multimeter probings.

What to look for in a scope depends on what you want to do with it. One of the first choices should be bandwidth, because high speed increases the cost, just as it does with cars or computers. If you plan to work only with basic projects or audio, you can probably make do with a bandwidth of 500kHz or less, although these days even the lowest cost scopes tend to have at least 5 or 10MHz of bandwidth. If you want to examine very high speed signals, you'll pay vast quantities of money to exceed 100MHz. You can also get by with a single trace, but the ability to view two signals (such as input and output) is well worth the extra expense. You can also work up some tricks, such as using the two channels as X and Y inputs to display the VI characteristics of diodes and transistors.

The scope shown in the photos, a GW Instruments 543, was reviewed in last month's issue, and is a good example of a general-purpose dual-trace model with good high-speed performance. Selling for $1125, it reaches 40MHz and has a com-

prehensive triggering section for stable displays.

Another possibility is to find used equipment in a surplus store or electronic flea market. The price is usually right, but I've found that, in general, the test equipment at $20 per box casts your testbench in a whole new light. Instead of cutting a swath through your list of projects, you just go from fighting with a multimeter to fighting with every piece of equipment on the bench. Your one hobby in life becomes trying to produce and display a stable signal.

However, if you like that sort of challenge, or if your spouse insists on throwing the money away on frivolities like food and rent, there are lots of deals available. In some cases, you may have to take what you can get, but if there's a good selection, look for a DC-coupled scope with triggered sweep and rotary switches with clickstops for vertical gain and sweep (as opposed to continuously variable pots). The DC coupling is necessary so you can see if DC is getting in where it should or shouldn't be. Triggered sweep is absolutely necessary for a stable display, and scopes with only a Sync control let the signal roll and blur and dematerialize. The switches instead of pots give you repeatable settings that can be used for measurements.

The Generator

Once your scope is working, you'll need something to look at. I recall making a sinewave oscillator out of a twin-T filter with the amplitude adjusted with a trim pot. The distortion was terrible, especially if you changed ranges.

There are two basic types of signal generators on the market, the standard sinewave oscillator, which may or may not have a squarewave output as well, and the function generator. The sinewave generator has the advantage of (usually) very low distortion, low cost and simple circuitry. The amplitude is stabilized by controlling the feedback with a FET, a light bulb filament or a thermistor, all of which cause a certain amount of amplitude bouncing at low frequencies or when you change ranges. The GW Instruments 808B is typical of economical sine wave generators at $230 (FST out), featuring a range of 10Hz to 1MHz, +/-0.5dB. It can produce a sinewave of 7V or a squarewave of 10V peak-to-peak. One of its best features, and one to look for on generators, is the built-in attenuator, which reduces the signal in six 10dB steps in addition to the rotary level control. This gives you very fine control of signal levels, particularly in the millivolt region where the pot adjustment is too coarse.

The squarewave function is a good one if you do any audio work; a rule of thumb is that an amplifier must have a minimum bandwidth of 1/10 to 10 times the square wave frequency if the wave is to look at all square. In other words, to pass a 1kHz squarewave that looks like a squarewave, an amplifier needs a bandwidth of at least 100Hz to 10kHz. Further, you can test tone circuits because the square wave horizontal lines act like a poor man's spectrum analyzer: the bass and treble controls tip it this way and that, letting you know right away if anything is out of the ordinary.

The output impedance of most generators is 600 ohms with the signal polarity swinging above and below ground, ideal for most work, but a bit awkward to use for driving logic circuitry.

The other main type is the function generator. These generate a triangular wave by charging and discharging a capacitor; the triangle is then squared up with a comparator, and also changed to a sinewave by various means, such as the nonlinear characteristics of a diode or bridge matrix. This gives you a choice of three outputs. In addition, the circuit can be voltage controlled over a wide range, usually three decades (1000:1); you can sweep over most of the audio range with a single pot. The low frequency performance is usually much better than the sinewave oscillator. The GW Instruments 8016D, at $470 (FST out), is a typical example, with sine, square, triangle, ramp and pulse outputs from 0.2Hz to 2MHz. There's an output that can drive TTL or CMOS logic circuitry; when set for CMOS, the level is adjustable up to 15V. To monitor the output frequency, it includes a digital frequency counter, which also has an external input.

If you need a signal source for a lot of different uses, it's hard to beat the function generator; its only drawback is somewhat high distortion on the sinewave, typically about 1%. This is countered somewhat by the very flat amplitude response, usually +/-0.1dB over most of the range.

The Multimeter

The most difficult thing about buying a multimeter is making the choice. You can find meters from under-$100 handhelds to precision bench models. There isn't a great deal of difference between models in the same price range, other than number of digits (3 1/2 or 4 1/2) and precision (most bench models are 0.1% DC accuracy or better). A handheld is probably best for starters. One thing I do like about bench models is that they have LEDs instead of LCDs, making them a bit more visible when you're testing.

Some of the units, such as the GW Instruments 8045, feature true RMS detection. This is a very useful feature whenever you need to know the power dissipated in a load driven by a nonsinusoidal waveform. If you put a train of voltage spikes into a resistive divider, will it make smoke or not? There are two ways of finding out: let it blow up, or invest in true RMS detection. It's not an essential feature, but if you can get it, go for it. The 8045 is $590, FST not included.

Power Supplies

There are more power supplies than DMMs out there, making the choice difficult. Again, it depends on what you plan on doing with it. There's hardly a testbencher who hasn't started off with a transformer/rectifier, with the output voltage adjusted by means of dropping resistors.

Once you get tired of hacking at resistors and decide you'd like some convenience, a regulated supply is the only way to go. Aside from unchanging output voltage, one of their strongest points is the ability to sharply limit the output current. This lets you turn down the output capability and prevent a blast if anything goes wrong in your circuit (a rare occurrence, I know). A good example of a supply that can do just about everything is GW's 3030. It has two 0-30V 2A supplies which can work separately, or be connected in series for higher voltage or in parallel for higher current. One of them can become the master and the other will track it. On the front panel are two 3 1/2 digit meters for monitoring voltage or current, and two 5V outputs, one with 1A and the other with 3A. Whether you work with computers, logic control or complex audio equipment, this would meet every possible need. It sells for $750, FST not included.

Other Equipment

Other equipment? You want *more?* Well, there's no end to the supply of test equipment that's available, from specialized handheld gadgets that do only one thing to complex analyzers. We'll be covering much of this equipment on an ongoing basis in all future issues.

For further information on the equipment mentioned in the examples, contact Duncan Instruments, 121 Milvan Drive, Toronto, Ontario M9L 1Z8, (416) 742-4448. ■

FOR YOUR INFORMATION

Silicone-Based Resin Blend System

G.E. Silicones is producing a new silicon-based resin blend system for paints and coatings. The TRIPLUS resin family was developed as a solventless, 100-percent silicon formulation, designed to give the end user a product with the properties of toughness, flexibility and high temperature protection. The silicone-based system for various coatings has key performance characteristics of low volatile components (VOC), low viscosity, adhesion to many substrates without the need of a primer, and high temperature resistance.

The system is comprised of two resins – one (TPR 178) for flexible coatings and the other (TPR 179) for rigid coatings. The two resins can be blended together to provide an unlimited range of coating capabilities to suit a multitude of applications eliminating the need for other coating products. The resin-based coatings can be pigmented with aluminium, titanium dioxide, metallic oxides etc. and offer protection up to 649°C (1200°F). These non-gloss materials can be applied to a surface as hot as 600'198F for on-line paintability. The material can be formulated to comply with environmental protection legislation standards.

Circle No. 3 on Reader Service Card

Electrovert Introduces Hollow, One Piece Injection Molded Components

Electrovert, manufacturer of production equipment for the electronic industry, has acquired exclusive manufacturing and marketing rights in North and South America for a process and system that enables molders to produce hollow, one piece plastic components having complex internal geometries.

Pioneered by Fry's Metals Ltd., U.K., the "Metallic Core Technology " (MCT) process combines the use of low melting point alloys and the "LMD 2000" system to produce the cores utilized during the molding process. Once the plastic part is molded around the metal core, it is melted out via the fully integrated LMD system. Engine inlet manifolds, fluid reservoirs and water pumps are just a few of the components proven viable for the MCT process.

Circle No. 2 on Reader Service Card

Surface Mount Quality Control

Materials Innovation of London, Ontario, announces the availability of their Solder Paste Quality Assurance Analyzer, a device that monitors solder paste tackiness by simulating the actions of a surface-mounted component placement robot. It can be operated manually or automatically, using a PC-compatible microcomputer. Testing and analysis are completed within three minutes at the press of a button. The accompanying software includes other operating features, such as statistical process control charts. Materials Innovation Inc.

Circle No. 4 on Reader Service Card

Filtronetics Inc. Enters the Canadian Market

Filtronetics designs and manufactures more types of custom electronic filters than any other company in the U.S. by covering a wider range of frequencies. This includes passive LC filters, crystal filters, programmable active filters and microwave filters for military and commercial use. In addition microwave capability comprises of custom designed combiners, power dividers, mixers, switches and micro strip filters. Calbrooke Marketing will be responsible for all Filtronetics current and future custom filter business in Canada.

Circle No. 5 on Reader Service Card

Alkaline Resist Stripper

Hysol Electronic Chemicals has developed a new alkaline resist stripper that speeds the strip and dissolve cycle for fully aqueous photoresist films. Hysol Deltastrip 775 strips 1.5 mil resists in one minute or less. It can be used in spray of immersion systems and will rapidly dissolve films from between overplated fine line traces. Deltastrip 775 is also recommended for some semi-aqueous dry films. The formula contains no glycol ether solvents and has a high loading capacity for longer bath life. In addition, it contains special anti-tarnish agents that leave the copper plate bright, ready for automated optical inspection and solder mask application. The stripper does not darken solder plated PWB's.

Circle No. 6 on Reader Service Card

Telecommunications Agreement Signed

The Canadian government, through the Export Development Corporation, is financing a $212 million loan to the Office National des Postes et des Telecommunications of Morocco. The loan, guaanteed by the Kingdom of Morocco, is in support of a contract to Bell Canada International for the installation of 300,000 new telephone lines in phase one of Morocco's telecommunications development plan.

Electro-Optic Probe

AT&T Bell Laboratories have developed a probe capable of measuring voltages in integrated circuits and high speed devices. This blend of optics and electronics opens up new avenues for the characterization of devices and circuits. With the new probe, engineers can test a circuit without making physical contact or connections with the circuit itself. It is one hundred times faster than the fastest sampling oscillloscopes.

Fourth Annual Kyoto Prize Awards

Created in 1984 by Kazuo Inamori, a Japanese industrialist and humanitarian, the Kyoto Prizes recognize outstanding accomplishments in three fields not named by the Nobel Prizes: Advanced Technology, Basic Sciences and Creative Arts and Moral Sciences. Each year's Kyoto Prize laureates receive academic honors and a cash award of 45 million yen (approximately US$340,000). Receiving the 1988 Kyoto Prize in the category of "Advanced Technology" will be Dr. John McCarthy, aptly known as the "father" of artificial intelligence.

Among Dr. McCarthy's achievements is the creation of the Time-Sharing System which paved the way for most of today's large-scale computor installations. In addition. McCarthy is the originator of the computer language LISP, which is now used by nearly all researchers in the field of artificial intelligence.

Continued on page 21

Circle No. 7 on Reader Service Card

F E A T U R E

The Canadian High Technology Show

Looking at the Mecca of technology.

BILL MARKWICK

The Canadian High Technology Show opened September 27 for the three-day run at the Canadian National Exhibition buildings in Toronto. An estimated total crowd of over 20,000 visited the record 1050 booths, which accomodated exhibitors from North America, Europe and Asia. The show could be broken down into three major segments, running concurrently: general high technology, production and packaging, and the test and measurement displays.

On entering, we passed through the production and packaging section, where the immediate message, to judge from the rows of industrial PCB-making machines, is that surface mount devices are taking over. The displays varied from small hand-held repair tools for the service bench to huge board-stuffers, complete with X-Y robot arms and laser scanners to check for missing components. The reduction in board size resulting from SMD packaging has spurred manufacturers to adopt the new method, and has no doubt bedevilled service people who don't have microscopes for eyes when it comes to testing and repairing the tiny chips.

After an acre of packaging equipment, the T&M section beckoned, guiding you along miles of colour-coded carpet, which was a nice touch, because after two days of looking at more dials and switches than the mind could absorb, it was nice to have the carpet let you know where you were. The T&M displays confirmed the trend that's been building over the last few years, which is Automated Test Equipment (ATE). The power of the microcomputer is put to work via various interfaces which connect to the test points of the equipment that's being produced or repaired. All sorts of analyses and diagnostics can be run this way, and the obvious moral to the story is the simplifying of servicing—eventually, there may be no more pick and poke with a scope probe.

In general high technology, however you define the phrase, there were more computer peripherals than there are computer owners. Plotters, printers, robot arms, tape and disk drives, motion controllers, computer-controlled milling machines—every possible toy for the gadgeteer.

There were many seminars produced by various companies for the industry members benefit, and the show always has awards as part of its promotion; the Best Canadian Product was a modular measurement and control for industrial process monitoring, from Sciemetric Instruments.

In general, there were no real surprises or revelations, but a confirmation of trends. Design, production, testing and servicing of products is more and more coming under computer control, either mainframe or micro. Robotic arms and motion controllers are replacing hand labour on production lines; in fact, the integrated system can take a design drawing done with CAD and use a computer-controlled milling machine to produce a 3D model that can be used for the casting process, etc. Bench technicians have more and more diagnostic aids for digital and analog equipment.

Thirty years ago, high technology was going to give us personal helicopters and weekends on the moon. The real outcome was a revolution in design and production, mostly as a result of the microchip. ■

THE SCIENTISTS TELL ME

DAVID P. DEMPSTER

Search Goes On for New Superconductor Materials

Physicist Jurgen Franck and his small group of researchers at the University of Alberta are racing with scientists all over the world to create a new breed of ceramic superconductors. A superconductor is a material that, when caused to become extremely cold, loses resistance. Electricity can flow through it with no loss of power. This is a valuable property in power cables as, for instance, it allows energy to be transmitted without power loss. (Superconductors also generate a powerful magnetic field.)

A few months ago, temperatures below minus 250°C had to be reached before superconductivity was observed. But cooling a material down to these low temperatures is an expensive business. It takes liquid helium, which is scarce as well as costly.

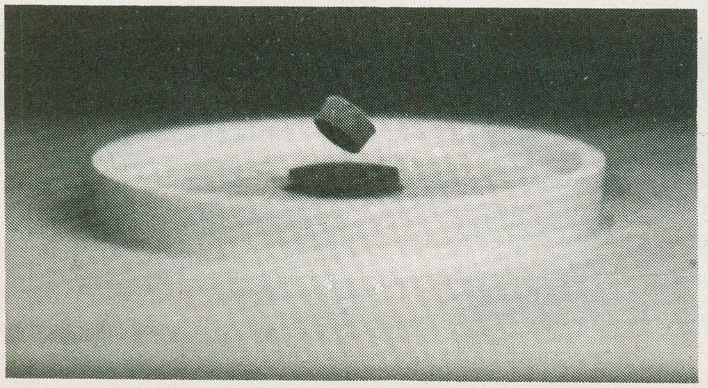
A major advance was made recently when researchers created a compound that was fully superconducting at around minus 180°C. This degree of cooling can be achieved by using liquid nitrogen, a medium that is cheaper than milk by the gallon and easily available.

"From a fundamental point of view of physics, superconductivity is an extraordinary phenomenon," says Franck. "Even a ball thrown through the air generates friction. With superconductors we have electrons going through a very dense material without any loss of energy at all. This is almost inconceivable." Every day in his lab Franck is making superconductors from new formulae, systematically varying composition and production methods, looking for that magic combination that will produce a viable superconductor able to work at temperatures much higher than used to be thought possible.

The basis for Franck's experiments is yttrium used as an oxide, barium used as a carbonate, and copper used as an oxide. "We are trying different proportions of these ingredients and putting in some other things," says Franck. "They are mixed up together, compressed and then fired in a high-temperature oven to make ceramic pellets. We are 'baking' them in different ways and cooling them at different speeds."The result is a mixture of compounds in one pellet. One of these compounds is usually superconducting. Unfortunately, the others are not. If researchers could only hit on the right ingredients, proportions and method, the pellet would consist of that one, ideal compound.

"However, the combinations are limitless," says Franck. "We mix, bake, test, analyze and then try again. There are so very many obstacles we must overcome. But from a practical point of view, there will be many applications. They may not come as fast as people in their original enthusiasm thought. At present it appears that thin film devices will be the first to find technological applications. But there is no doubt in my mind that there will be many more applications — we can't give up."

Dr. Franck's research is supported by the National Research Council of Canada."



A superconductor levitates above its bath of liquid nitrogen.

Tree rings are providing new information about our global climate.

For Yesterday's Weather — Read Tree Rings

Scientists have a fairly good grasp of how global climate has changed over tens of thousands to hundreds of thousands of years. They also know rather a lot about weather, monitored and charted daily in many parts of the world since the late 19th century. But what is understood about climate change on time scales from years to more than a millennium is another question. Although knowledge of weather over such time spans is limited, these time scales are arguably the most important to human society. Tree ring analysis is providing more information for long-term global climate study.

Some tree species will very sensitively record not only annual, but seasonal climate changes over thousands of years. Unfortunately, these tree types grow mainly in Earth's temperate zones, and most of the Southern Hemisphere's temperate zone is ocean. Also, global-climate researchers need to monitor climate change in such places as the tropics, where trees don't put down neat, annual rings.

It seems that researchers face an exciting prospect of breaking out of their geographical limitations and looking at something close to global climate on these intermediate time scales, according to Malcom K. Hughes. He made this comment in an address before last year's meeting of the Geological Society of America, when they held their 100th annual meeting in Phoenix, Arizona. The prospect is integrating what is known from the tree- ring record with what is known from other datable biological and geological records," he said.

Hughes is director of the University of Arizona Laboratory of Tree-Ring Research, the world's largest and foremost centre of tree-ring collection and study. The laboratory was the first of its kind when established 50 years ago at Arizona by Andrew E. Douglass, the father of a now international science called dendrochronology. ("Dendro-" from the Greek word for "tree" and "chronology" meaning the study of time.) UA tree-ring scientists have constructed more than 8,000-year continuous chronology for trees in western North America.

"We're already talking about not just patching together a data base of the climate record over the last few hundred or thousand years, but actually developing a framework of ideas within which to put all the different records together," Hughes stated. He envisions collaboration between tree-ring researchers, ice core scientists, expert interpreters of annually layered coral reefs or deep ocean sediments, and others. For areas where the tree- ring record is poor, the ice core record can be good. This is the case not only at the polar ice caps, but, for example, in the glacier-bearing Andes Mountains for South America or in the glaciated ranges of Tibet. For the ocean-covered tropics, changes in climate are recorded in layers of floor sediment or coral.

By piecing all the records together, collaborating scientists could develop global maps that show climate change season by season, year by year, over a long period of time, Hughes said. "We don't know just exactly how we're going to play that game at this point; we have to be careful not to get involved in a circular patching of some dates to fit other ones, and then drawing conclusions." he added. "But the

prospect is exciting."

Just as UA tree-ring laboratory scientists Charles Stockton has drawn a picture of periodic large-scale drought in North America, or as UA dendrochronologist Harold Fritts has mapped North American climate change back to the 1600s, global scientists would be able to study the effects of El Nino, the southern oscillation. We could note how volcanic eruptions affect climate, and the consequences of increased atmospheric carbon dioxide.

"In each case, what we're focusing on is an exploration of past climate targeted on the mechanisms that might be changing that climate," Hughes said. And on time scales important in human terms.

A Breakthrough in Spinal Cord Research

A team of researchers at the Case Western Reserve University School of Medicine has made a major breakthrough in spinal cord research; for the first time they induced functional nerve regeneration into the spinal cords of mammals with a paralyzing sensory injury. Results from their studies suggest that similar strategies eventually could be used to repair damaged nerve pathways in paralyzed humans.

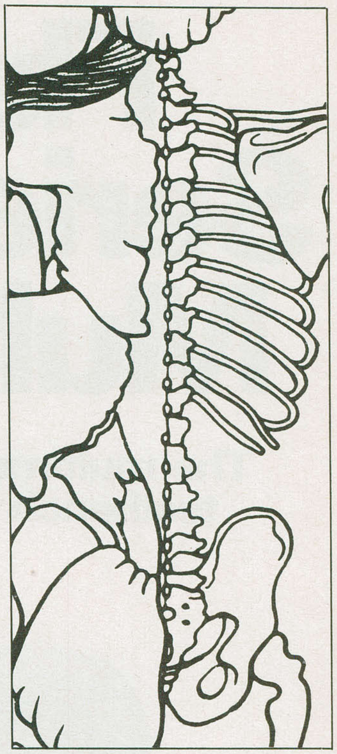
Jerry Silver, Ph.D., associate professor of Developmental Genetics and Anatomy, presented the results of the research before the annual meeting of the Society for Neuroscience when it was held in New Orleans last November. The procedure, which has induced nerve regeneration and restored sensory sensation to the toes in several laboratory rats, was developed by Dr. Silver and several colleagues.

The rats' sensory roots, near the entrance point to the spinal cord, were damaged surgically under anaesthesia. In a second surgical procedure, a specially designed polymer bridge coated with fetal neural cells was implanted into the spinal cord. In seven rats, nerve regeneration occurred and sensation was restored to the paralyzed limbs after about 10 days. The type of fetal neural cells used (a form of astrocytes) are the only cells that inhibit scar formation and provide the highway over which nerve fibres can regenerate. "The manner in which we injure the rats' sensory roots is analogous to the way a ruptured disc in humans can crush peripheral nerves as they enter the spinal cord," Dr. Silver said. "It can cause permanent sensory paralysis in the limb, an absence of withdrawal reflexes, and difficulty moving the limb because of lack of sensory feedback."

The researchers chose the model because it is simple and has striking behavioral deficits that can be monitored and quantitated. "While an injury of this type is not as serious as quadraplegia, it is part of the same problem — the failure of nerve fibres to regenerate," he stated.

Not only have the researchers seen improvement in behavioral deficits, but also evidence of anatomical restoration. "The exact relationship of the incoming fibres with the cellular portion of a number of unique synoptic terminal malformations in a subpopulation of fibres that took unusual routes have convinced us that the fibres in the cord are truly regenerated." Dr. Silver said.

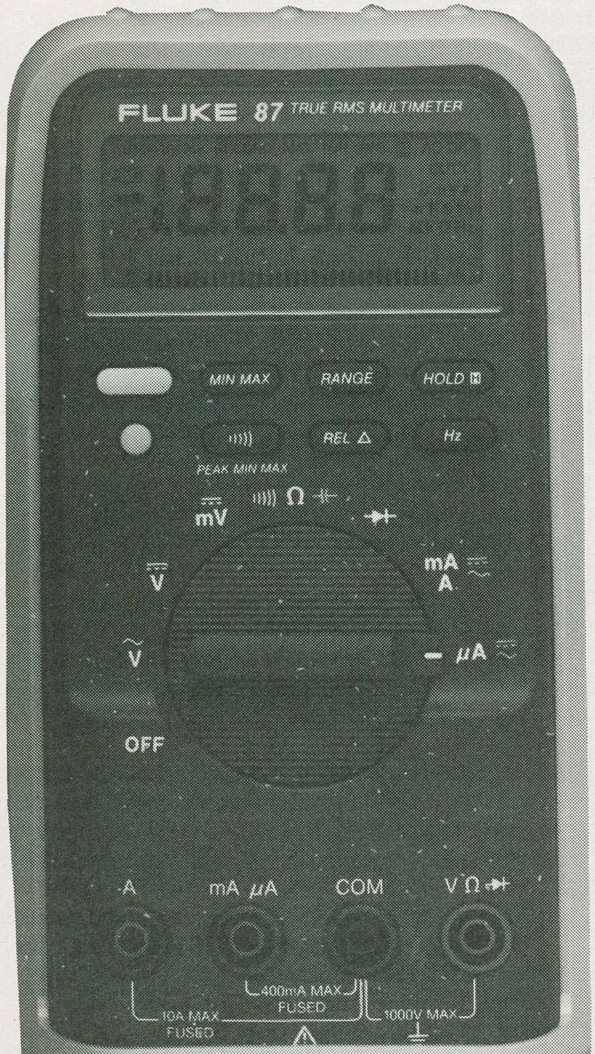
What next? The researchers plan to devise more reliable surgical techniques because placement of the tiny bridge is crucial. Another step is to understand better why this procedure works on a cellular and gross level. "We need to know if time is crucial," he said. "Can the astroglia remove a chronic scar? After that we can try this procedure on primates." ■



Fluke 80 Series Digital Multimeters

The multimeter becomes a miniature testbench with the new 80 series.

BILL MARKWICK



Five years ago, the John Fluke company introduced the 70-series of handheld digital multimeters. They were the DMM rethought, featuring a rotary switch instead of baffling pushbuttons, an analog bargraph that let you watch the behaviour of rapidly changing voltages, autoranging and drop-proof construction. Options included a hold function for taking readings in awkward places.

The new 80-series tops them. The three models, the 83, 85 and 87, have the same basic look and rugged holster, but advances in single-chip design and manufacturing mean that they're literally stuffed with features. These advanced features mean that they're not only convenient around the testbench, but lend themselves to working with the ever-increasing complexity of today's electronic equipment.

Basics

All three models have a 4 1/2 digit LCD with the analog bargraph along the bottom, and all functions have autoranging with a manual override. Display update time is 4/sec, with 40/sec for the analog bargraph. AC volts can be measured from 0.1mV to 1000V, DC volts from 1mV to 1000V, DC millivolts from 0.1mV to 400mV, and ohms from 0.1 to 40M. The inverse of the resistance function is conductivity, measured in Siemens from 0.01nS to 40nS; this lets you measure such difficult things as diode or insulation leakage.

An unusual feature for a DMM is the capacitance range. It directly tests capacitors from 0.01nF to 5uF; larger capacitors can be measured by timing how long they take to charge fully.

The usual diode tester, with a 3-volt range, can handle up to five silicon diodes in series. The beeper can be switched on or off.

The AC/DC current range can handle readings from 0.1uA to 10 amps, 20 amps if the test is brief.

Even more unusual than the capacitance meter is the addition of a frequency counter. It can measure from 0.5Hz to full scale, and can also display the duty cycle ("on" time) in percent. Basic accuracy is 0.005% with an update time of 3/sec for signals higher than 5Hz. The current range can also be used to trigger the frequency counter.

The Rel key is used to make relative measurements above or below some particular signal level. The test leads are connected in the desired mode, and the Rel button pushed; the meter display will now

zero and the bargraph centre itself (with a x10 increase in sensitivity). If the input changes, the meter now displays the difference reading, a feature invaluable for peaking or nulling a circuit.

The last setting, but certainly not the last feature, is the Min/Max pushbutton. This lets you record minimum, maximum and average readings for up to 36 hours; the new values are automatically updated whenever the input changes. Pushing the Min/Max button cycles the display through the three stored readings.

Model 83

The Model 83 contains all the features described above, and costs $291 with the yellow holster and test leads. It has an AC bandwidth of 5kHz and a basic DC accuracy of 0.3%.

Model 85

In addition to the Model 83 features, the Model 85 adds 0.1% basic accuracy and an AC bandwidth of 20kHz. It costs $337 with the holster and leads.

Model 87

To all the above, the Model 87 adds a high resolution mode, 1ms Min/Max recording response, a backlit display, and true RMS detection (see below). It costs $398 with the holster and leads.

Switching On

If you've used the 70-series models, you'll notice on powering up that the 80s complete the self-check much faster, have quicker response on the continuity test and update readings much faster. The holster has a remarkable tilt stand on the back; it's flexible, and you can bend it into a hook if you want to hang the meter on a piece of equipment.

The meter has a particularly useful feature called Input Alert. If the test probes are connected to the current jacks and the switched moved to any other range but current, the beeper emits quick pulses. Anyone who has tried to measure volts with the leads in the current jacks will remember the sparks and can testify to the usefulness of this one.

Another interesting point is that various modes can be selected by holding down certain pushbuttons as the meter boots up. For instance, holding the blue Shift button and switching on will disable the automatic power-down if you need to watch readings continuously; otherwise it shuts down in 30 minutes if a switch hasn't been operated (except in the recording modes). Another option is the Min/Max high-accuracy mode, in which the sampling time is extended to one second. If you need super-high impedance on the DC mV range, you can boost it to 4000 megohms. Another extends the reading by one digit; in the normal mode, a 9V battery read 9.36, and in the extended mode read 9.365 (Model 87 only). There's another intriguing option briefly mentioned in the manual: the meter can be powered up so that the beeper is converted to a 16kHz ultrasonic transmitter, sending all displayed information at 800bps. While this function is for the use of Fluke service personnel, it's interesting to speculate whether it might be possible for the user to transmit meter data this way for remote measurements.

Power for the meter is from a 9V alkaline battery, which gives a typical life of 500 hours. The low-battery indication leaves you with about 8 hours remaining, enough to continue testing before having to change the battery. There is no AC adapter jack.

True RMS

The Model 87 features true RMS detection of AC voltages, RMS being the value of the AC waveform that gives the heating power, or DC equivalent. Both mechanical meters and rectifier DMMs read the average value of the input waveform, storing the variations either through mechanical inertia or capacitor charge. Since sine waves are generally used for AC work, the meter display markings or digits are calibrated to convert the average to RMS. In most cases this is acceptable; 10V AC is equivalent in terms of power to 10V DC.

However, if the waveform is nonsinusoidal, such as a square wave or a pulse train from a triac or a very distorted audio signal, the relationship doesn't hold, and the average-reading meter will be in error. If you have to know the proper value of these waveforms, something you'd need in R&D, for example, RMS detection is invaluable. I've often noticed on true RMS meters that the AC response may be slowed by the conversion circuitry, which is usually a thermistor or a log/antilog circuit, but the Model 87 is as fast as you'll need. If you do any sort of work involving nonsinusoidal waveforms, true RMS is for you (a 120V lamp dimmer produces curved spikes into a 100 ohm resistive load—how much power is being dissipated? Nothing to it with the Model 87).

They've Done It Again

The price range of the 80 series puts it above the 70 series; Fluke has now covered everything from the basic DMM to what amounts to a handheld testbench (will the next series include a small oscilloscope?). The quality of manufacture and design is second to none, and there are quiet features that may be overshadowed by the gee-whiz aspect; for instance, the buttons, jacks and display are splash and dust proof, and the construction of the meter gives it a high degree of safety (similar to the 20 series industrial models) if you work with hazardous voltages.

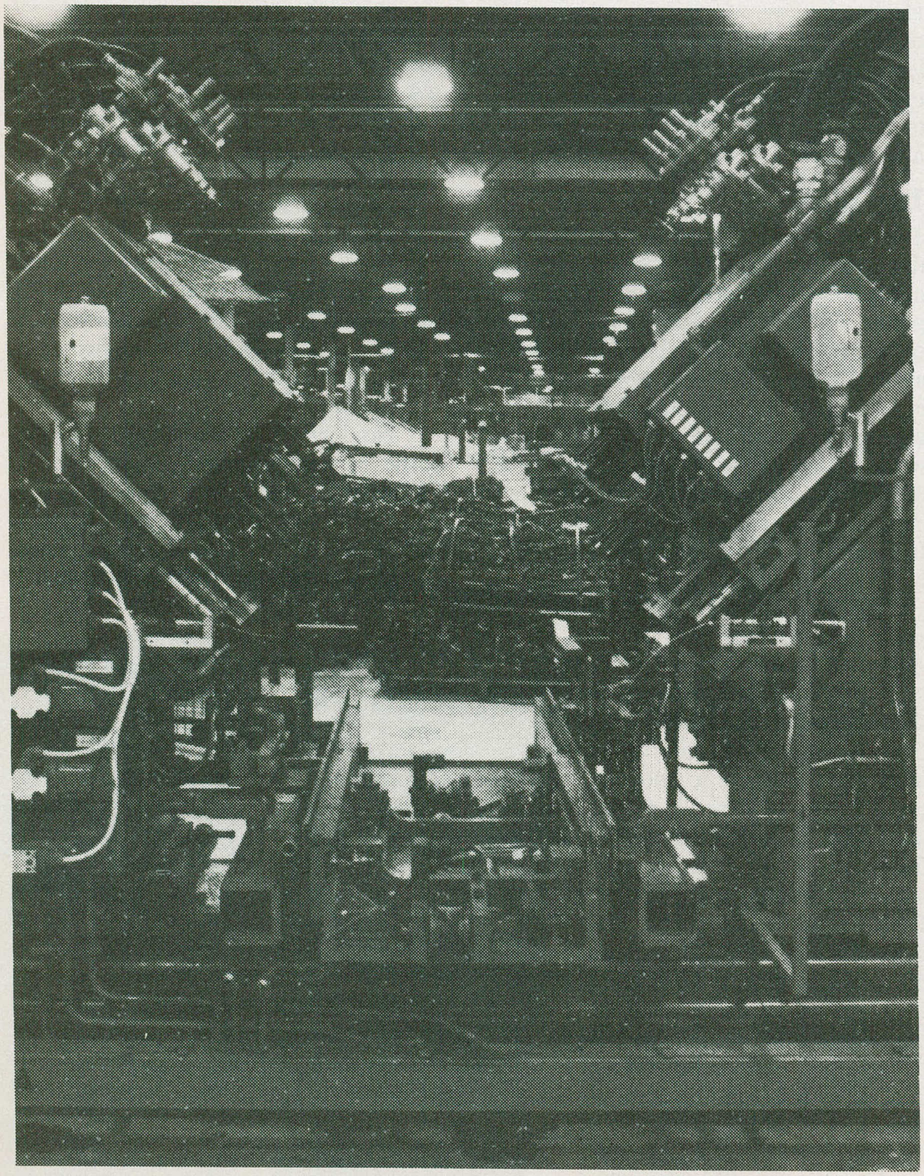
At one time, measurements such as frequency and capacitance were considered to be fairly specialized, and were well taken care of by dedicated (and large) pieces of test equipment. With today's consumer and industrial equipment containing ever more complex circuitry, the technician needs more test functions in the field, and a more convenient approach to them on the bench. I mention this because many designers lean toward "feature overload"; once you have a microchip in the box, you have to find lots of things for it to do to impress the buyer. The 80 series doesn't fall in this category. Every feature appears to be well thought out and implemented.

No doubt the 80 series will do for top-of-the-line handhelds what the 70 series did for the basic DMM. Fluke instruments are available from distributors across Canada; for further information, contact Fluke Electronics Canada, (416) 890-7600. ■

Safety First For Industrial PC Use

It pays to play it safe.

DR. H. VIRANI



Industrial machines of this type can function safely and efficiently through programmable controllers.

Programmable controllers (PC) are so easy to program and use that safety aspects, which would never be overlooked in a hardware control system, are sometimes never addressed. This article outlines some methods of increasing the safety of programmable controllers, controlled machines, programming techniques, physical installation practices, software diagnostics, maintenance considerations, and human factors that can help reduce the possibility of errors.

Economics of Safety

There are many reasons for being aware of safety in PC based control systems - but people have to be on the top of the list!

Preventing even one injury, or worse yet, a death, should satisfy even the most hard hearted that the small extra investment is justified. Also, the cost of damaged or spoiled products, due to a machine error far outweighs the cost of thinking ahead and preventing at least the obvious errors. Lastly, preventing damage to the machine being controlled by stopping dangerous motions before they cause problems will provide more up-time and a lower cost per unit for manufacture. Thus, better safety not only prevents injuries to people, it helps the entire system operate more efficiently.

The cause of unsafe control systems and machines are as varied as the machines themselves. But one of the major contributors is the ease with which a modern PC can be programmed. When PC manufacturers make it easy for designers to enter logic into the machine, they also make it easy to enter mistakes. It doesn't take much thought and effort to get the system up and running, and this simplicity tends to make the designer overlook things he would normally consider.

The ease of programming brings up another problem - that of unauthorized personnel making changes to programs. Many maintenance personnel and operators are allowed access to a PC; while they possess excellent job skills in their field, many lack the knowledge to program a PC safely. Even persons who do know how to program a PC may not know the procedure followed in your plant, and may make program changes that function properly but lack safety considerations. In some plants, Prom or Eprom memory for program storage might be the only protection against unauthorized tampering. Consider such a feature when deciding which PC to use for a particular application.

Dealing With Outputs

The primary techniques for increasing safety lie in the coding of the program itself. One of the most abused is the latched output i.e. an output that stays on once it is been activated. Latches are great for storing error codes, but problems arise when these latched coils are used to control "real-world" outputs. This is because conditions which make a particular output necessary during a machine cycle can change while the power is off. The latched output, however, will still be on regardless of the input conditions, possibly causing a serious or dangerous machine motion to occur immediately upon power-up. All outputs that cause any machine movements should be programmed with non-retentive outputs. If it is necessary to hold them up, use a hold circuit and seal in contacts just as you would with relays.

Most PCs provide I/O cards with isolated inputs and outputs. If you are controlling motor starters in a remote motor control centre, use isolated 120 volts outputs. You can never tell what phase is going to be used at the remote area, or where the power is going to come from. It pays to play it safe. Also, if the remote motor control centres have ground fault interrupt (GFI) protection (and they should), consider monitoring the state of the ground fault interrupt device in the main control program. When interfacing your system to a remote machine, use isolated I/O to prevent ground loops, common mode voltages, shocks, and other electrical problems. Use reed-relay contact outputs and isolated inputs, and make all interface wiring yellow or some other distinctive color for easy identification.

To decide how to specify limit switch wiring, remember that they are not all necessarily normally open (NO) devices. Use NO or NC (normally closed) switches for the greatest safety. For example, if the limit switches are on a hydraulic cylinder, decide which switch covers the most unsafe position, and make that switch normally closed. The most common failures are either a broken wire or an unmade contact, so if the wire or switch fails, the PC will sense an unsafe condition. If you wish to have all your inputs consistent within the program, simply invert the sense before using them. In a PC with an Exclusive OR data function, a complete word of such inputs can be inverted by Exclusive ORing with all ones (Fig.1).

If this is not available, energize an internal output with the "off" limit switch input, and then use that output as the limit switch in the program. In very sensitive areas, where safety is of extreme importance and both positions of the cylinder are potentially unsafe, wire both the NO and the NC contracts to two separate inputs.

When using these inputs, insure that both are in their correct state before allowing the machine to proceed. Examine all the outputs carefully with regard to the PCs "last state" function; that is, what does the PCs I/O rack do to the output signals if fault occurs? Turn them off? Maintain the last output state? In the case of a CPU fault or power surge, not all outputs are safe when turned off. A pump maintaining hydraulic pressure, for example might be safer left on rather than turned off. If the PC doesn't maintain the last state, consider the use of "Rack Fault" switches. Here, a separate smaller rack is used for outputs that need to stay in their last state during a fault. In any case, don't just blindly assign everything to shut off after a failure.

Fig.1

```
Input data word: 11001100 11100111
XOR with all 1s: 11111111 11111111
                 -----------------
                 00110011 00011000
```

Don't Trust the Hardware

When controlling anything that can do harm to the product, to the machine, or to a person, don't control that motion with a timer. Mechanical parts can slow down or speed up, but timers don't re- adjust to keep up. Also don't assume that a motion occurred because you sent an output to cause it. Use a limit switch input to verify that the movement did in fact happen.

If photocells or proximity sensors are used, make them failsafe, just like the limit switches. Photo electric sensors should be designed into the machine so that the dangerous condition breaks the beam. If the bulb burns out, the unsafe condition will be indicated. When you are unable to arrange this, write the program to check the photo cell when it is illuminated, at least once every cycle. In very sensitive situations, use a current sensor in the lamp or LED circuit to monitor the light. Proximity sensors, likewise, should provide an off signal when the unsafe condition is present. These, too can be checked during another part of the cycle to verify proper operation.

If a conveyor belt or pump must be on for safe operation, use some sort of feedback to make sure. This can be as simple as an auxiliary contact on the motor starter. Belt motion can be sensed by a tachometer. A running motor can be sensed by current sensors in the lamp or led circuit to monitor the light.

Installation Aspects

When grounding control elements, read and follow the manufacturer's recommendations. Make sure all parts of the PC, the power supplies and the cabinets are grounded with heavy gauge copper wire. Use the necessary power conditioning on all ac lines and install transient protectors across motors, solenoids and other inductive components that are switched by "hard" contacts. Noise on the ac lines can cause spikes on the power supply, and spikes on the power lines can cause intermittent errors in the logic. And logic errors can cause the machine to destroy parts, waste products, and even kill or maim personnel.

Don't let the "magic" of the PC make you forget that some things must be hard wired. For example, all emergency off actuators and circuits need to hard wired. Make sure that when power is cycled off and on the control relay doesn't pick up by itself. Wire your circuit, so that a manual reset is required before power returns to the machine.

Diagnostics for Safety

Most PCs use an internal "watchdog timer" for monitoring internal functions, and they belong in your program also. Overall cycle time of the machine can be monitored with a timer preset for about 120% of the normal time. Reset the timer once each cycle, and if the time is ever out, it will indicate something is wrong (hopefully before an accident occurs). Many machine motions can be monitored with one timer set up as a master clock. As each motion finishes, compare the time with a stored valve, and set off an alarm if the time exceeds the norm. A 10% to 50% leeway should be allowed, depending on the safety impact of each motion to prevent nuisance alarms.

Data comparison is very powerful diagnostic tool. For example, inputs can be examined during a portion of the machine cycle when conditions are known and static. This method lets many sensors malfunctions be detected before they cause trouble. Discrete I/O points can be checked one at a time, or whole input

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Safety First For Industrial PC Use

words can be checked. For this to be really efficient, inputs can be grouped on the I/O modules during the design stages.

Maintenance Considerations

Many PCs allow "forcing" inputs and outputs (that is, an input or an output can be turned on or off manually, regardless of process conditions). Forcing I/O is often done during maintenance or troubleshooting to simulate inputs or to bypass certain portions of a program. Usually, forcing is allowed only in one section of the I/O rack at a time.

Using Extreme Caution With Such Features

Forcing I/O in one section can cause outputs previously forced off in another section to come on at once, with disastrous results. Again, by anticipating for safety, you can group all related I/O in one section to allow future forcing without causing unexpected results. In a conveyor system, all stops could be wired to the same input group; this allows forcing the I/O to manually run a load through the system during troubleshooting. Other problems occur when you alter a program while the machine is running.

Even changing the preset of a timer at the wrong time can cause unexpected actions to occur. On-line programming is especially dangerous. Use the CPU key lock provided by the manufacturer or install your own to prevent indiscriminate on-line program changes by maintenance personnel. PROM program storage will be the best answer to the problem.

Keep the maintenance function in mind during all your design plan. Give technicians overrides for watchdog timers and safety circuits where necessary - if you don't, those safety circuits may mysteriously disappear from the program. Maintenance overrides, while necessary, can be misused.

Consider Operator Needs

Estimates are that 40% to 50% of the reliability of a system is attributable to its operators. Thus, it pays to consider them during the design. Get input from the people who will operate the machine on matters such as placement of alarms and indicators. The operator must be able to understand the controls and react to alarms in a manner and time frame sufficient to prevent accidents. If operators help design the console, they will be able to run it better.

Remain consistent with terms and abbreviations throughout the machine and within the organization. Colors should have the same meaning everywhere and emergency conditions should always be shown in the same manner. Emergency stops must either always turn on, or always turn off the stop lights - not some on and others off. Alarms should indicate severity by placement, color, and even sound, if applicable.

Minimize False Or Meaningless Alarms

Lights that are almost always on are often ignored in an emergency. Provide a means to override any noncritical alarms during maintenance activities to give more importance to serious alarms. In any case, don't allow any inactive alarm indicators to remain on. For maximum effectiveness, every alarm the operator sees should be real. Set the trip levels at reasonable levels to minimize unnecessary activation. If necessary, consider providing two alarms levels - yellow and red, for example. Requiring a reset button to be pushed twice in the event of a serious fault can prevent accidental machine restarts that could have disastrous results.

If your console has some type of machine parameter display, use a logical arrangement so that relationship to the machine is obvious. Where many conditions must be displayed at the same time, use methods to assist the operator in understanding them. Wherever possible, let the PC, not the operator, verify that necessary actions have taken place. For instance, if the operator requests a pump to start, program the PC to check after a reasonable delay to verify the starting and alert the operator only in case of a malfunction. If you can reduce the operator workload by extending this concept to all important movements, you can allow him or to go about their job more efficiently and safely.

Safety After Start Up

Most systems using programmable controllers have a surplus of memory available after the machine control program has been written and debugged. Many times extra memory is included just because " we might need it". Use some of this memory to provide diagnostic and safety features to enhance the rest of your safety-oriented design.

Guard against adding so much protective gadgetry that the original function of the machine is encumbered. Safety functions must complement, not get in the way of the real purpose of the machine. Those that do get in the way will eventually be removed, leaving a machine with no protection for itself, or the people and products around it. ■

Breaking Glass Alarm

Added protection for your home. Senses ultrasonic sounds generated by broken glass.

ROBERT PENFOLD

As most readers will be fully aware, the human senses are not without their limitations. In particular, the eye only responds to a very small part of the range of frequencies generally accepted as being forms of light, and the ear can detect sound waves over a relatively small range of frequencies. Although you cannot see infra-red or hear ultrasonic sounds, they are both present as part of our natural surroundings.

Electronics seems to be increasingly involved with these unseen and unheard parts of the electromagnetic and sound spectrums. They find use in such things as remote control systems, automatic light switches, and intruder alarms.

Ultrasonics

The unit featured here is a form of intruder alarm, and it makes use of ultrasonic sound. However, it is not of the usual "Doppler Shift" movement detector or broken beam varieties. It is designed to pick up the ultrasonic sound waves produced when an intruder tries to break into premises by breaking a window.

On the face of it, the use of ultrasonics in this application is unnecessary, since breaking glass produces strong sound waves in audio spectrum, and a normal sound activated switch should do the job equally well. In fact there would seem to be advantages to an ordinary sound switch in that it would probably give greater range and a less restricted angle of "view". Ultrasonic sound waves tend to be highly directional, and to be more readily absorbed by air than audio frequency sounds.

There are in fact advantages in using an ultrasonic system. With most types of burglar alarm, there is no real difficulty in obtaining good sensitivity. The main difficulty is in avoiding false alarms.

False Triggering

A unit which responds only to ultrasonic sound is likely to be less prone to false alarms as there are fewer sources of strong ultrasonic sounds in most environments. The directivity of ultrasonic systems is helpful in cutting out possible causes of spurious triggering.

The same is true of the high absorption of high frequency sound waves in air. The chances of loud but distant sounds activating the unit are quite remote. For example, something like a low flying aircraft would be quite likely to activate an ordinary sound triggered switch, but would be very unlikely to trigger an ultrasonic type.

An aircraft probably produces some ultrasonic sound, but very little of what is produced is likely to reach the ground. The same is also true of thunder, with its predominantly low frequency content. Another advantage of ultrasonics is that, unlike low frequency sounds, they are largely blocked by windows and walls.

Alarms of this type are not totally immune to false alarms, but they are generally accepted as being less prone to problems in this respect than many other types of alarm. The most likely cause of a false alarm is when strong audio sound waves vibrate something in the vicinity of the alarm and cause it to produce ultrasonic sound waves.

Apparently it is important that all the broken glass should be removed when a smashed window is repaired, including any tiny chips, as these can be stimulated into producing ultrasonic sound waves by strong audio frequency sounds. Breaking

glass alarms have been known to operate when a window in another building some distance away has been broken. This is almost certainly due to this phenomena of audio to ultrasonic conversion, rather than direct pick up of the ultrasonic sound over a long distance.

As described here the alarm is a self contained battery powered unit having a built-in two tone alarm generator circuit. It is intended to act as a simply stand-alone burglar deterrent, but the unit could probably be incorporated into a comprehensive alarm system without too much difficulty by someone with a reasonable knowledge of electronics.

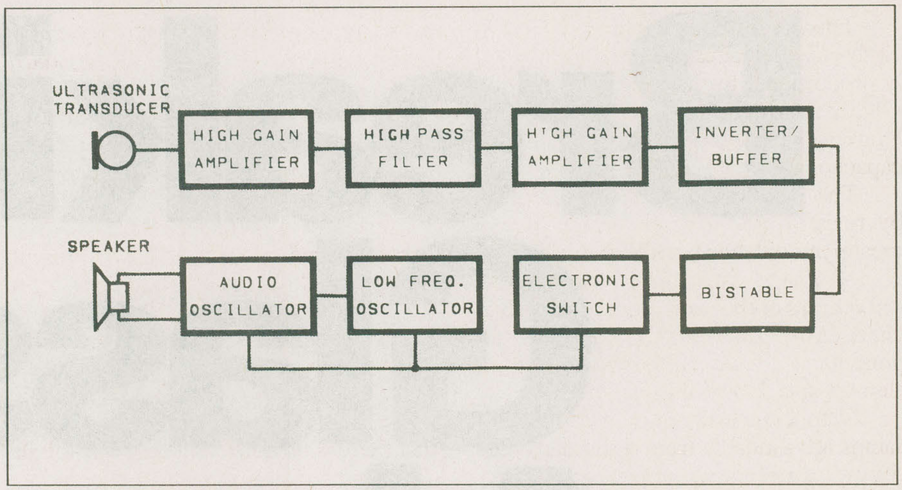


Fig. 1 Block diagram of the Broken Glass Alarm system.

System Operation

The block diagram of the overall make-up of the Breaking Glass Alarm is shown in Fig. 1, and helps to explain the way in which it functions. Ordinary microphones are very inefficient at ultrasonic frequencies, and so an ultrasonic transducer (of the type designed for remote control applications etc.) is used at the input of the unit.

Although ultrasonic transducers have a sharp peak of sensitivity centred on a certain frequency (usually 40kHz), they offer quite good sensitivity over a much wider frequency range. I tried out several different types of transducer, including 25kHz, 32kHz, and standard 40kHz components, but it was a 40kHz transducer that gave the best results.

The output level from the transducer is not likely to be very high, and so this signal is boosted by a high gain amplifier. The next stage is an active high-pass filter which severely attenuates any audio frequency signals produced by the transducer.

The sensitivity of an ultrasonic transducer is very low indeed over most of the audio frequency range, but a significant output signal can be produced over the upper part of the audio spectrum. This filter greatly reduces the risk of audio frequency signals spuriously activating the alarm. The filter is followed by a second high gain amplifier stage.

This gives quite a strong output signal when breaking glass is detected. The function of the rest of the circuit is to convert the strong ultrasonic sounds into a switching action that operates an alarm generator circuit, and keeps it switched on indefinitely.

The latching action is provided by a bistable circuit that is driven from the output of the amplifier via an inverter/buffer stage. An electronic switch is driven from the output of the bistable, and at switch-on the bistable is provided with a "reset" pulse that places its output low and turns off the switch.

Normally the output voltage from the amplifier is too high to "set" the bistable, but when an ultrasonic sound is detected the bistable is "set" on the first negative half cycle, at the output of the amplifier. Once "set" the bistable remains in this state until it is manually "reset".

The alarm generator is controlled by the electronic switch, and it is therefore activated when the switch is turned on. The alarm is a form of two-tone type, where the pitch of the audio frequency oscillator is swept up and down between two pitches by a low frequency oscillator. This gives a sort of warbling sound that is quite penetrating and effective as an alarm sound.

Circuit Operation

The full circuit diagram for the Breaking Glass Alarm appears in Fig. 2.

MIC. 1 is the ultrasonic transducer and the first amplifier is a common emitter type built around transistor TR1. This stage runs at a fairly low collector current of well under 1 milliamp, but it still provides a high level of gain over the ultrasonic range of about 20kHz to 80kHz. Transistor TR2 is an emitter follower buffer stage, and this is needed in order to give a low output impedance to drive the next stage.

This is conventional active high-pass filter having transistor TR3 as the buffer stage. The filter is a "four-pole" (24dB per octave) type having a cutoff frequency of slightly over 20kHz. The output of the filter is coupled by capacitor C6 to the input of the second amplifier stage, which is another common emitter type.

Preset control VR1 enables the quiescent output voltage of the amplifier to be adjusted. This permits the output voltage to be set high enough to ensure that the unit is not simply activated at switch-on, but low enough to give good sensitivity.

The inverter/buffer stages uses a CMOS quad 2-input NOR gate, IC1a, wired as a simple inverter, and two of the other gates of IC1 are cross-coupled so that they act as a basic bistable circuit. Capacitor C7 and resistor R11 provide the positive reset pulse to the bistable at switch-on. One gate of IC1 is left unused, and its inputs are tied to the positive supply rail to protect them against static damage.

The electronic switch has the common emitter stage based on transistor TR6 driving a second common emitter switch (TR5). This combination gives very high gain, and can easily handle the fairly high output currents involved when the alarm is activated.

Alarm Generator

Both the oscillators in the alarm generator are standard 555 astable circuit. IC2 provides the low frequency modulation while IC3 operates as the tone generator. The modulation is applied to pin 5 of IC3, and it has the effect of varying the charge and discharge thresholds of IC3. This gives frequency modulation, and with capacitor C9 omitted the operating frequency of IC3 is simply switched between two frequencies. Capacitor C9, in conjunction with resistor R14, provides lowpass filtering that produces a smoother transition from one frequency to the other, and a somewhat more effective alarm signal.

The basic frequency of the alarm is easily changed if desired, and it is inversely proportional to the value of capacitor C10. Similarly the modulation frequency is inversely proportional to the value of capacitor C8.

The modulation depth is controlled by resistor R14 (lower values giving greater modulation), while the values of both R14 and capacitor C9 control the smoothness of the modulation. By making changes to the values of these components a considerable repertoire of alarm sounds is available.

Output currents of well over 100 milliamps are available from a standard 555 timer, and using an eight ohm loudspeaker quite high volume levels are achieved. The unit is certainly adequate in this respect for a simple burglar deterrent for use indoors.

A load impedance as low as eight ohms can tend to "pull" a 555 oscillator off its natural operating frequency, but a good alarm sound should still be obtained even if this should happen. A higher impedance loudspeaker can be used, but these seem to give significantly lower volume levels. The use of an "improved" version of the 555 for IC3 is not recommended, as many of these devices are low power types which have much lower maximum output currents than the standard device.

Burglar alarms often incorporate a timer that automatically shuts off the alarm a few minutes after it has been activated, so as to prevent the alarm from causing a public nuisance. This feature has not been incorporated in the present design, and it would be of limited value in a low power unit for indoor use.

S1 is the on/off switch, and the alarm is reset by switching off, waiting a second or so, and then switching on again. It is advisable to use a key-switch for S1 so that there is no quick and easy way for an intruder to silence the alarm once it has been activated.

The stand-by-current consumption of the unit is only about 1 milliamp. This is low enough to permit economic battery operation, and six good quality size cells fitted in a plastic holder are sufficient to power the unit for well over 2000 hours of operation, which equates to around 3 to 4 months of continuous operation. Assuming the unit is used intermittently, the batteries will have something not far short in their "shelf" life.

Note that once the unit is activated the current consumption increases to something in the region of 80 to 90 milliamps. A fairly high capacity battery must be used in order to allow this fairly high current drain to be met, as well as to give good battery life.

Construction

The printed circuit board accommodates all the components apart from the loudspeaker, battery on/off switch and microphone. The component layout and full size copper foil master pattern is shown in Fig. 3.

Construction of the board presents little that is out of the ordinary, but bear in mind that IC1 is a CMOS device and that it consequently requires the usual antistatic handling precautions. Also, do not overlook the single link-wire just to the right of resistor R19. Pins are fitted to the board at the points where connections to off-board components will be made.

A plastic case having an aluminum front panel is used as the housing for the prototype, this has approximate outside dimensions of 161mm by 96mm, but a somewhat smaller case should be capable of accommodating everything. For any security application it is advisable to use a reasonably tough case, but in this application it is not essential to use something as

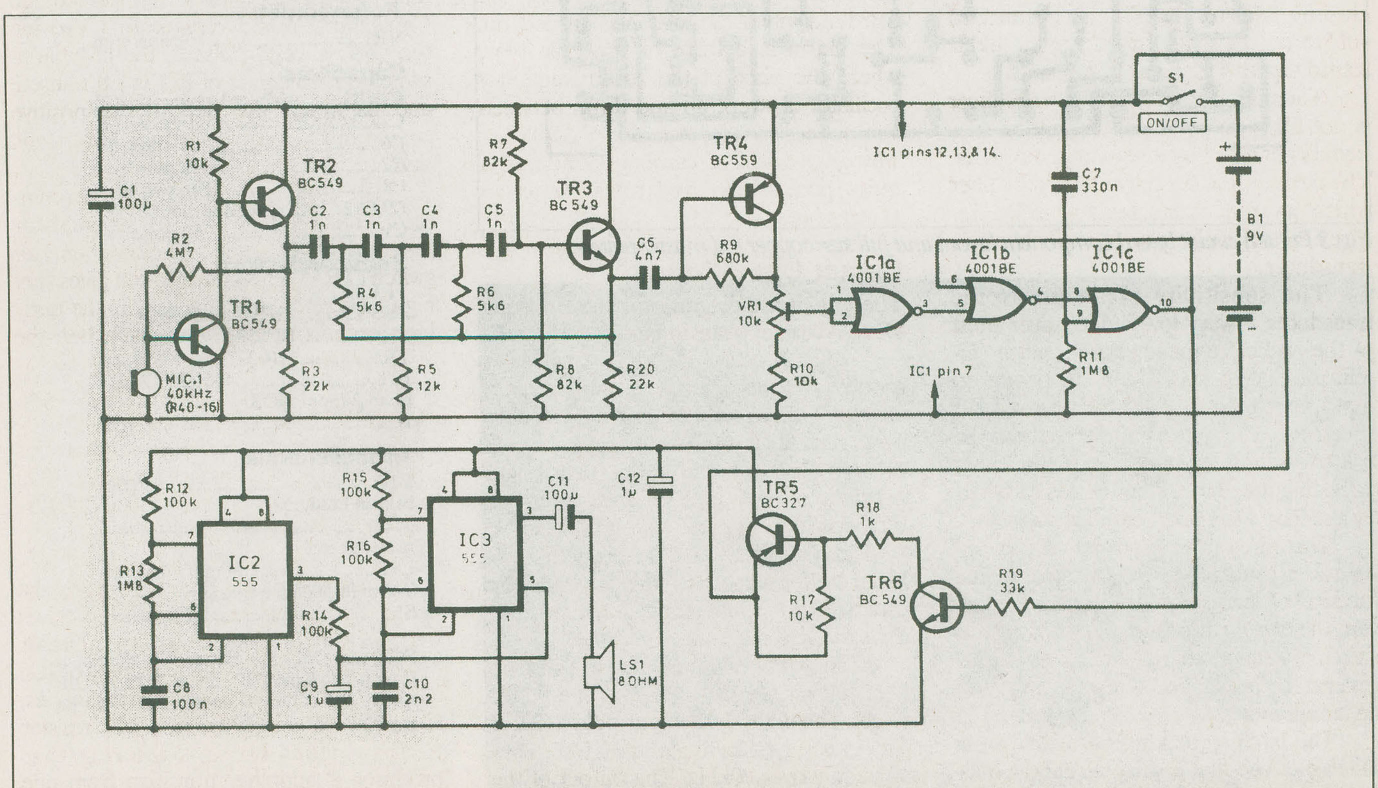


Fig. 2 Complete circuit diagram for the Breaking Glass Alarm.

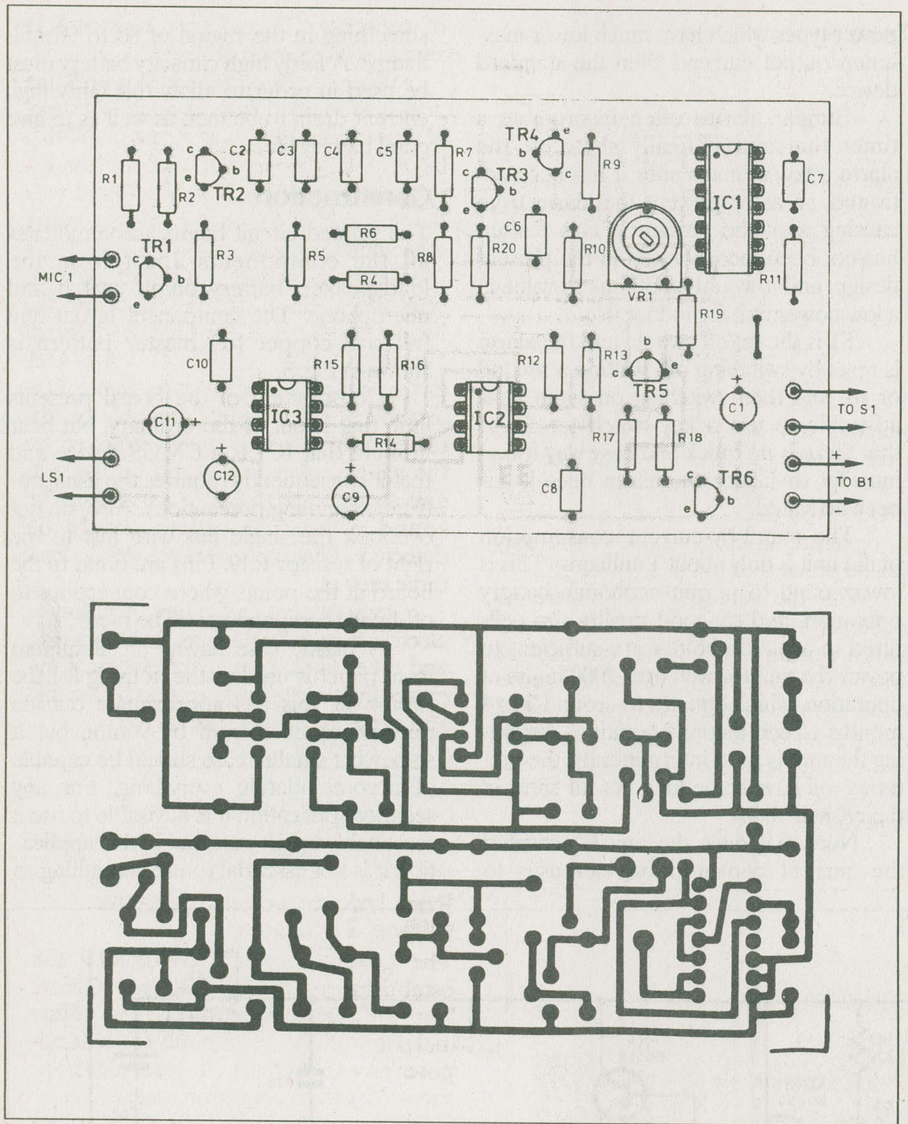
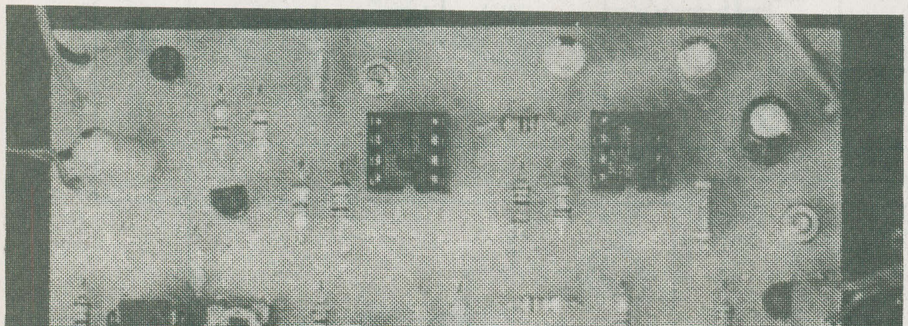


Fig. 3 Printed circuit board component layout and full size copper foil master pattern.



Layout of components on the circuit board.

hardy as a diecast aluminium or heavy gauge steel type.

Switch S1 is mounted on the right hand section of the front panel, and the component used required a 20mm diameter mounting hole which was made with a chassis punch. This seems to be typical of the mounting requirements for key switches. The loudspeaker is mounted to the left of S1, leaving space for the batteries to fit between these two components.

A loudspeaker grille can be made by drilling a matrix of holes about 5mm in

PARTS LIST

Resistors

R1,R10,R17 .... 10k(3)
R2 .... 4M7
R3,R20 .... 22k(2)
R4,R6 .... 5k6(2)
R5 .... 12k
R7,R8 .... 82k(2)
R9 .... 680k
R11,R13 .... 1M8(2)
R12,R14,R15,R16 .... 100k(4)
R18 .... 1k
R19 .... 33k
All resistors 0.25W 5% carbon

Potentiometer

VR1 .... 10k hor. trim

Capacitors

C1,C11 .... 100u radial elec.10V(2)
C2,C3,C4,C5 .... 1n polyester(4)
C6 .... 4n7 polyester
C7 .... 330n polyester
C8 .... 100n polyester
C9,C12 .... 1u radial elec.63V(2)
C10 .... 2n2 polyester

Semiconductors

TR1,TR2,
TR3,TR6 ...... BC549 or 2N3904 npn
TR4 .... BC559 or 2N3906 pnp
TR5 .... BC327 or 2N5819pnp
IC1 .... 4001BE CMOS
quad 2-input NOR
IC2,IC3 .... 555 timer(2)

Miscellaneous

B1 .... 9V(six cells in holder)
Mic.1 .... 40kHz ultrasonic transducer
LS1 .... 80mm diameter 8 ohm impedance speaker
S1 .... Keyswitch

PCB; case (161 x 96 x 59mm) with aluminum front panel; 8-pin DIP socket(2); 14 pin DIP socket; 9V battery connector. TR5 can be any PNP capable of 800mA or more.

diameter. Be very careful with the positioning of the holes as it is a lot more difficult to make a really neat job of this than you would imagine.

With miniature loudspeakers there is usually no obvious means of fixing them in place, and it is generally a matter of carefully gluing them in place using a good quality adhesive such as an epoxy type. Try to avoid smearing adhesive onto the diaphragm.

The situation is similar for the ultrasonic transducer (MIC. 1), which is mounted on the left hand end panel for the case, and which will almost certainly have to be glued in place. The unit will probably work quite well with any 40kHz ultrasonic transducer. To complete the unit the small amount of point-to-point style wiring is added. The connections to the battery holder are made via an ordinary PP3 type battery connector.

Many ultrasonic transducers have one terminal connected to their metal case. With such transducers this terminal should be the one which connects to the negative supply rail.

Testing and Use

After giving the wiring a thorough final check, set preset VR1 at a mid-setting and switch-on the unit. The alarm will probably not be activated, but if it is, switch off again and set VR1 fully clockwise. The alarm should then fail to activate when the unit is switched on again.

It is not necessary to smash glass to test the unit, and any ultrasonic sound in front of the transducer should activate it. Rubbing your fingers together in front of the unit should be sufficient.

By adjusting VR1 in an anticlockwise direction it will probably be possible to gain some increase in sensitivity. However, it is probably best to adjust VR1 well off the point at which the alarm is triggered, as otherwise the unit may well be prone to spurious triggering.

With the prototype there were no problems, with vibration from the on/off switch tending to trigger the unit at switch-on. However, if this should prove to be problematical making the initial reset pulse longer by increasing the values of capacitor C7 and (or) resistor R11 should eliminate the problem.

When deciding where to install the unit, bear in mind that the angle of "view" of the transducers is fairly narrow. With a large window, or several windows side-by-side, coverage will probably be better with the unit angled across the window rather than aimed perpendicular to it.

During experiments, using two transducers connected in series, with the two of them aimed in slightly different directions, seemed to work quite well, giving a wider acceptance angle. Optimum reliability would probably be obtained with the transducer mounted on the window, but this would be likely to give away the presence of the alarm. The sound of breaking glass should be detected reliably at a range of at least three metres.

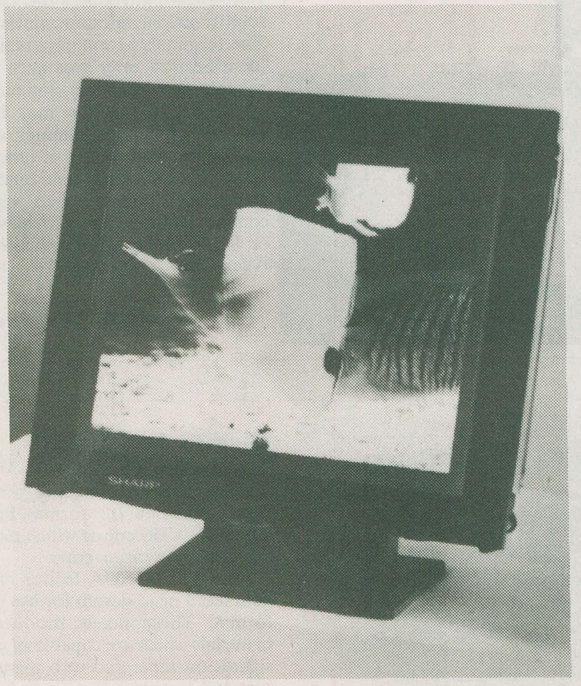
Avoid mounting the unit very close to electric fires, refrigerators, mains wiring, and other likely sources of electrical impulses that could be picked up by the unit and cause false alarms. ■

FOR YOUR INFORMATION

Continued from page 7

World's First 14 Inch Colour LCD

Sharp Corporation of Japan has developed the world's largest colour liquid crystal display (LCD) panel, measuring 14-inches diagonally and just over one-inch thick. The super-thin active- matrix LCD incorporates 308,160 pixel elements (or 1.2 million colour dots). The colour display includes a specially designed active-matrix drive system whereby individual pixels are divided into four active dots, each controlled by its own amphorous silicon thin-film transistor (TFT). The LCD will be incorporated into office automation equipment and TV sets beginning late 1989.



Circle No. 12 on Reader Service Card

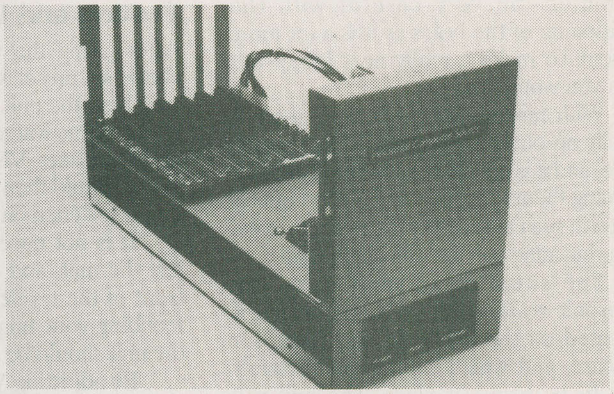
Port Information Systems Office To Open

The government has announced the establishment of the National Office, Port Information Systems. The office will serve as the focal point for federal-government activity in the development of port information systems.

The computer-based electronic data interchange (EDI) systems will eliminate most of the paperwork involved in the process of shipping goods, and in doing so, improve the efficiency and competitiveness of major Canadian transportation center. As local systems covering air, sea and overland transportation are put in place, the National Office will act to ensure they can communicate with one another.

Port information systems development initiatives are being pursued in Vancouver, Montreal, Halifax and Windsor. A Vancouver-based company, CANSIF Canada Enterprises Inc., is receiving a total of $500,000 from the Dept. of Communications and the Canada Dept. of Western Economic Development to assist in its initial development efforts. ■

NEW PRODUCTS

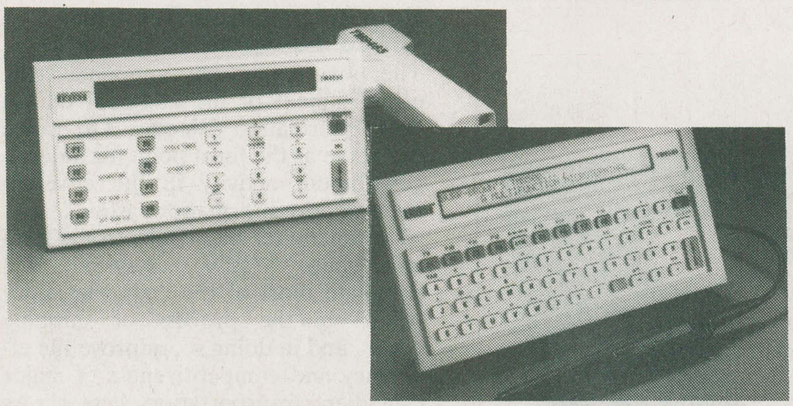


Diskless Computer

Industrial Computer Source introduces its NODE-XTC and NODE-ATC Diskless Computer. The NODE series has a 75 Watt power supply 110/220 VAC operation for international requirements. A 12 VDC and 24 VDC option is available. The NODE chassis incorporates a 6 slot passive backplane design and can be configured as an IBM PC/XT, PC/AT or a 386 PC/AT system. ICS offers a variety of plug-in CPU cards for use with the NODE. The B880 is a PC/XT plug-in CPU card designed to operate and function like a standard IBM PC/XT motherboard. The B286 is equivalent to a 10MHz 80286 AT motherboard and the B386 CPU card to the IBM PC/AT providing a 16MHz 80386, up to 8Meg of 32-Bit RAM and optional 80387.

The complete system is about the size of a shoebox, allowing installation on the factory floor or inside NEMA inclosures. The NODE is designed for installation in factory environments , where use of floppy drives is ill-advised or where space is at a premium.

Circle No. 13 on Reader Service Card

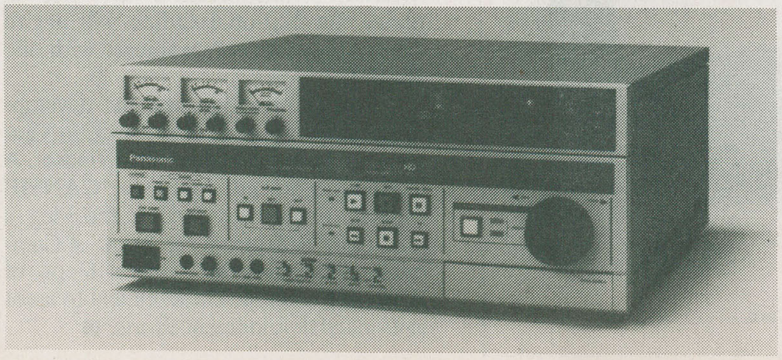


Multifunction Terminals

Burr-Brown introduces the TM8500/8550 series of compact multifunction, microterminals for data entry and display. The terminals accept data manually and through automatic identification interfaces such as bar code wands and slot readers, laser scanners, and magnetic stripe readers.

Keyboard function may be logically redefined (non-volatile) by the programmer, and the keycaps can be easily rearranged. Two banks of function key memories provide a total of 32-40 character functions strings which may be stored in a terminal's non- volatile RAM. A built-in host communications port provides a jumper-selectable RS-232 or RS-422 interface. Available in Canada exclusively from Allan Crawford Associates.

Circle No. 14 on Reader Service Card



S—VHS Editing VCR

The introduction of the S—VHS format in 1987 made it feasible and economical to generate serious video productions in the new 1/2" format. Panasonic has responded with a new S—VHS editor which produces even better results in the third generation copy.

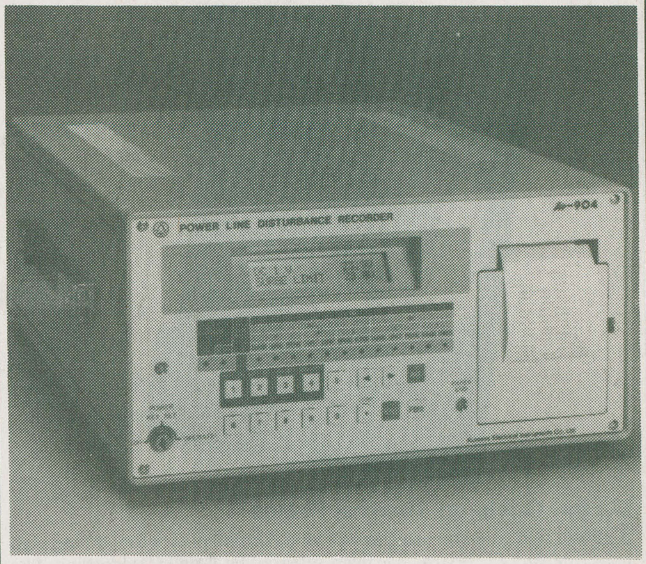
The AG—7500A Editor makes use of the amorphous laminated head design for use in the M—II broadcast video format. These heads produce extremely thin layers of materials which are capable of writing and reading stronger-signals on tape, and also providing longer head life. Matsushita Electric of Canada Ltd.

Circle No. 15 on Reader Service Card

Multimeter With Printer

Hioki's new model multirange, multifunction unit with printer can be linked with others for multichannel recording of volts resistance current as well as temperature, RPM, KW, KVA, KVAR and illumination with optional accessories. Printing intervals range from 10 second to 1 hr. An optional AC adaptor is available to preseve battery life. RCC Electronics Ltd.

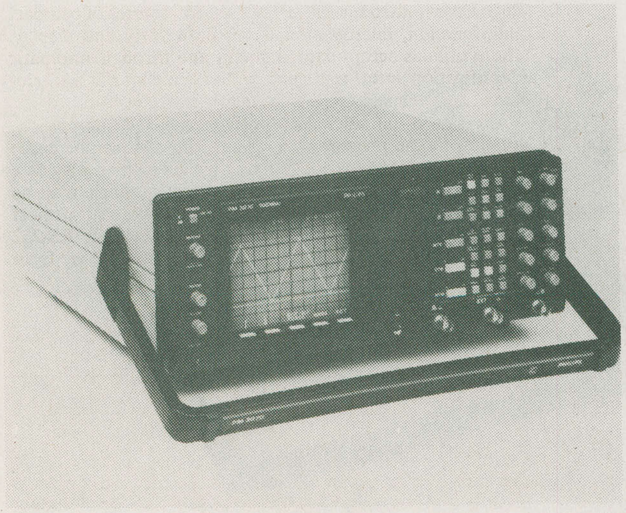
Circle No. 20 on Reader Service Card



Power Line Disturbance Analyzer

The Kuwano AP-904 Power Line Disturbance Analyzer has been upgraded to measure 750V AC, so surges on 600 lines can be effectively monitored. It also measures voltage sags, frequency, high voltage impulses and current surges. The AP-904 comes standard with an 8-channel event recorder and alarm output terminals. DC voltages to 750V can also be monitored. When the input voltage level changes, the AP-904 prints an alarm message, channel number, status of event and time and date of occurrence. RCC Electronics Ltd.

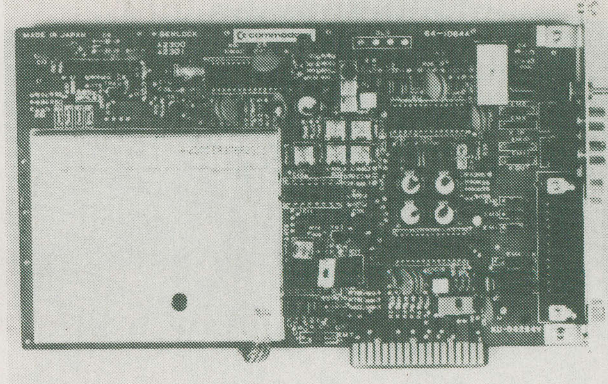
Circle No. 21 on Reader Service Card



100MHz Delayed Sweep Oscilloscope

The Phillips PM 3070 is a 100 MHz delayed sweep oscilloscope with full cursor measurement capabilities in both the time and amplitude axes. The PM 3070 is the most recent addition to the Phillips family of medium frequency analog oscilloscopes available from Fluke Electronics Canada, all of which are designed for ease-of-use with an autoset function for automatic display set-ups at the touch of one button.

Circle No. 22 on Reader Service Card



Graphic Images Enhanced

Commodore Business Machines Ltd. introduces the Amiga 2300 Genlock, a device which permits graphic images created with the Commodore Amiga 2000 computer to be overlayed on video sources from laser disks, video cameras or tape, or other computers. The Genlock allows the user to add titles, captions and other graphic images to video production.

The Amiga 2300 Genlock requires no external power suppply and fits into the Amiga 2000 video slot. It is designed for semi- professional users and hobbyists.

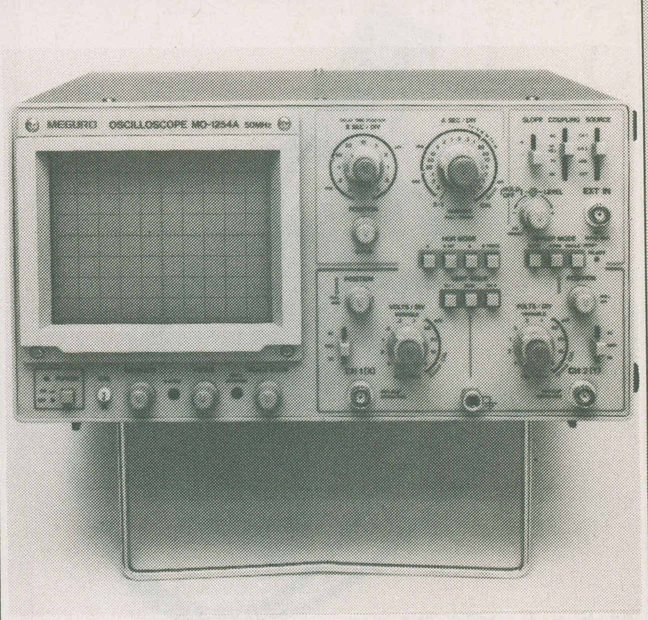
Circle No. 23 on Reader Service Card

Design Guide on Thermal Planes

A new design guide on using low-profile thermal planes for cooling high power density PC boards has been released by Aavid Engineering. The brochure describes how design engineers, faced with a growing demand for greater PCB power densities in smaller housings, can resolve the heat/space dilemma by using thermal planes. Low profile thermal planes add as little as 0.020 in. to the thickness of the PCB.

The brochures also provides information on the manufacturing technologies used in producing thermal planes, including metal stamping, photo chemical etching, and CNC milling. It covers design options, guidelines, and the materials and finishes available. Represented in Canada by Avotronics Ltd.

Circle No. 24 on Reader Service Card



50MHz Oscilloscope

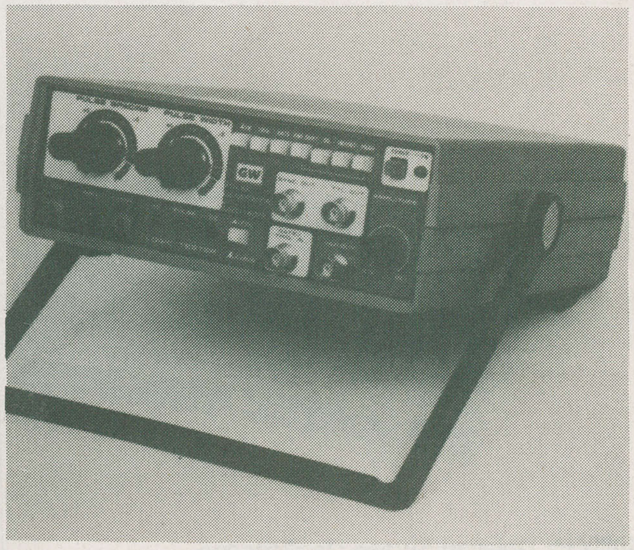
RCC Electronics Ltd. introduces the MEGURO MO – 1254A dual trace, 50 MHz bandwidth oscilloscope. It features 5mV to 5V/division sensitivity, x 5 magnification and delay triggered sweep. The MO-1254A measures up to 400Vp-p, with horizontal sweep time from 0.2 us to 0.5 s/division.

Circle No. 25 on Reader Service Card

One — Piece Video Recorder/Monitor

Panasonic has added recording capabilities to the AG-500 Player/ Monitor to create the AG-550. The AG-550 has a 4-head video system for noiseless slow motion and still fame playback. It offers 2/4/6 hour record and play, and auto repeat playback operation based on either Tape End or Video End. The front panel contains a digital clock and fluorescent display of tape operations. An optical soft-sided carrying case is available. Matsushita Electric of Canada Ltd.

Circle No. 26 on Reader Service Card



Pulse Generator/Logic Tester

A Pulse Generator/Logic Tester, Model GPG8018, is now available from GW Instrument, for use with CMOS and TTL circuitry. The GPG8018 can be used with an oscilloscope for adjustable sweep delay, or for testing counter circuits and shift registers, or for IC logic testing of TTL, CMOS and related logic families. GW Instuments is marketed exclusively in Canada by Duncan Instruments Canada Ltd.

Circle No. 27 on Reader Service Card

Continued on page 33

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MOORSHEAD PUBLICATIONS

ALMOST FREE SOFTWARE

VOLUME 39

This collection of programs is about as classic an almost free software volume as we've done in a long time. It has a vast cornucopia of stuff... we've wanted to call something a "cornucopia" for long time, too. There's a great game, a host of DOS utilities, some hacker things, some serious applications and even a few toys. All of the code in this collection has been checked within an inch of its life for bugs and viruses.

BOOM is a program to display fireworks on your screen. You probably don't think you need one of these... most likely true, but it's fun to watch. Requires a CGA or EGA card.

COLORDIR is a very slick... and exceedingly fast... sorted directory program which uses screen colours to make large directory listings easier to check out at a glance. A colour monitor, while by no means essential, is highly recommended.

DIGCLOCK is a huge screen clock which reads out in seven segment numerals. Easily read from across the room, or across the street with a good telescope.

DISPINFO is a C source file for programmers. It's a foolproof routine to allow your code to figure out what sort of video card is in the computer it's running on.

ED is another C source file, this one for the standard unix ed text editor. It has been reworked to compile under Turbo C, and will serve nicely as the basis for a word processor if you want to write your own.

EGA2RAM runs the BIOS of your EGA card from fast RAM rather than slow ROM. It speeds up your screen quite noticeably with no snow or other drawbacks. Requires an EGA card, ASM source code included.

FASTGIF is a GIF image file reader. GIF files are glorious colour picture files which must be seen to be really appreciated. We've included a GIF file of a mandrill so you can see what they're up to. Requires an EGA or VGA card.

HP-SLASH reduces the size of LaserJet soft fonts... and their resultant download time... by allowing you to selectively remove unused characters from them. This is an essential tool for anyone using a LaserJet compatible printer, especially with desktop publishing.

MAXI.EXE is the answer to every "insufficient disk space" message in creation. It formats up a normal double density floppy to hold four hundred and twenty kilobytes, and a quad density disk to hold almost a megabyte and a half. Our tests indicated that these disks are no less reliable than normal floppies, and can be read in normal PC drives.

PC-POOL is a really well executed pool simulation. The balistics of the balls is very nearly perfect, and the user interface is well thought out. It's not as gory as killing aliens, but it's better for your karma. Requires a CGA or EGA card.

REMINDER is a memory resident appointment calendar which pops up at the touch of an alternate key. It also features a screen clock which can be enabled or disabled at will.

RN is the best way to move around the subdirectories of a hard drive ever invented. Rather than having to type in complex paths, RN allows you to move around in menu driven comfort.

SAY is the best speech program we've encountered for the PC thus far. It's pretty inteligible, especially considering that it speaks through a speaker the size of a quarter connected to a timer chip. It comes with a host of phrases, including the all but essential "beam me up, Scotty". Good for disturbing your stupour in the morning.

VFM will warm the hearts of Ventura Publisher users. It allows you to add and reorganize fonts for this popular desktop publishing system without any sweat, bother or keying of batch files. No laser should be without one.

MCOPY is command line replacement for the DOS COPY command which allows you to copy files to floppies with maximum space efficiency, a prompt to swap floppies when the disk is full and full CRC checking to make sure that what you see is really what you get. DOS, as it turns out, doesn't verify its copies very well even with the verify flag on. This is an essential utility.

$19.95

VOLUME 40

SQUYNCH is an adventure game created with the Adventure Game Toolkit. Charged by Squeeb II to retrieve his ruby, you'll face various unpleasant obstacles in fulfilling his request. SQUYNCH has a sophisticated command parser which accepts complete sentences as valid input.

CRAPS is a realistic representation of the Las Vegas dice game. CRAPS' instructions include a thorough description of how the game is played and the odds of various bets paying off. You'll need a colour graphics card and ANSI.SYS in your CONFIG.SYS file to play.

PICEM16D allows users of CGA, Hercules and EGA as well as VGA graphics cards to view multi-coloured .GIF, .PIC and .PCX graphic files. Plantronics and AT&T graphics cards are also supported.

ROGER.GIF is a multi-coloured graphic of Roger Rabbit, a cartoon hare of recent cinematic fame. Best viewed on a colour monitor.

EDMAC allows users to edit and (optionally save) readmac graphic files. Good for cleaning up the extra bits inherent in files ported from the Macintosh. EDMAC is accompanied by its Pascal source code, and requires a colour graphics card.

OPUS is a readmac of Berke Breathed's Bloom County character in a questionable state of Penguin Lust ...

FOWLPLAY attempts to settle the question of why did the chicken (or turkey) cross the road. Similar to Frogger, this game requires a colour graphics card.

ATALK is a number of humourous digitised sentences which actually sound reasonably clear through your speaker.

$19.95

VOLUME 41

GALAXY24 is the latest version of the Galaxy word processor. Now equipped with a spelling checker, Galaxy allows the user to work on up to two textfiles at the same time and import text from one to the other. The colours Galaxy uses are user-selectable, and EGA owners may elect to display 43 lines of text instead of the standard 25. Galaxy can use the entire IBM character set, provides ten programmable macros to save you some typing, and will take advantage of a mouse, if you have one. Most popular printers are supported.

PC-TOUCH endeavours to improve your typing skills by recording your accuracy and words per minute as you type in the deep thoughts it throws at you from thinkers great and obscure. In executable form, PC-TOUCH comes with its BASIC source code, and allows you to change the quotes to virtually anything you'd like.

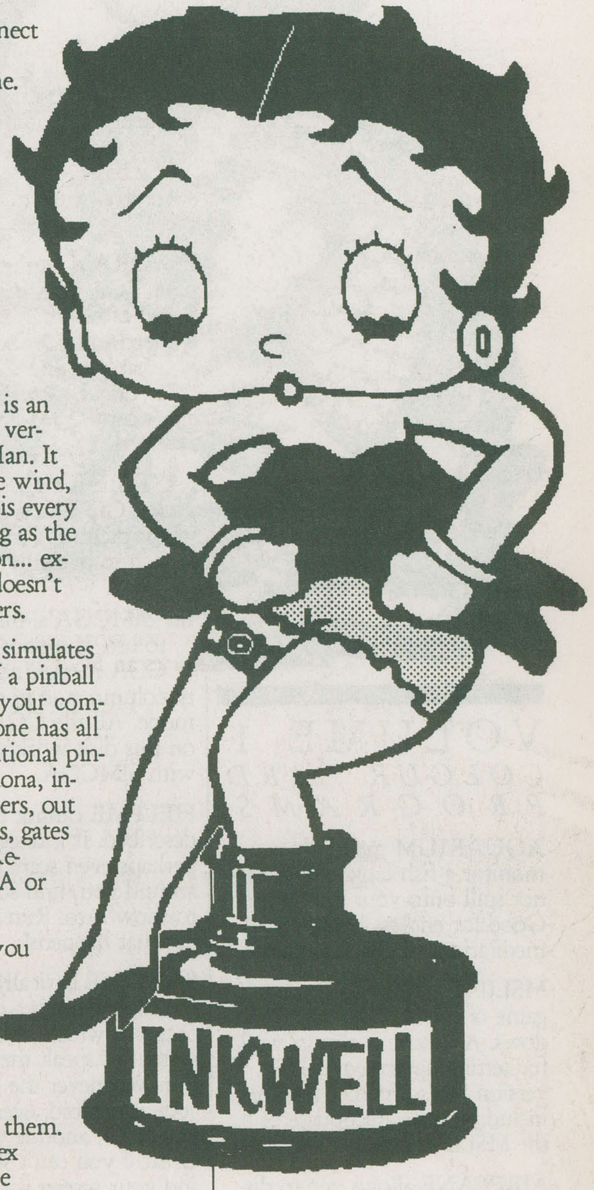
PHNWRD10 knows that you've always wanted to know what your phone number spells out, and is willing to display ... or print ... all 2,187 permutations to help you out. Few of these will actually make sense, but there may be an interesting phrase or three nestled in amongst the resultant cryptograms. **$19.95**

CHRISTMAS GAMES DISK

Christmas is a time of love, laughter, joyous abandon and playing computer games until your eyes hurt. Okay... traditionally that latter feature might not have been widely accepted, but anyone who gets into the true spirit of Christmas will realize that with all that time off work there's ample opportunity to get in a few phasor blasts now and again between the eggnog and scotch.

If someone you know likes to play computer games... or if you just want to spoil their concentration for the first half of the new year... why not give them the Almost Free Christmas Games disk. We've gone though our voluminous collection of games and chosen our favourites for this disk. It includes such classics as Castle, Trek, ChessII and EGAroids... plus a host of others.

The Almost Free Christmas Games disk comes complete with documentation on the disk and an attractive package suitable for wrapping. **$19.95**



CARD is a simple draw poker game. In addition to genuinely random play, you can shoot it if it cheats without having to worry about its brothers coming after you for vengance.

CASTLE remains one of the most fun public domain computer games yet devised. Wander around a sort of deserted castle collecting things and trying to find the way out. More fun than sudden, blistering death.

CHESSII is a pretty sophisticated chess game with a graphic board. You can actually pick up and move your pieces, rather than having to enter board co-ordinates. ChessII features multiple look ahead levels, too. Requires CGA or EGA card.

EGAROIDS is a brilliantly executed Asteroids game for EGA and VGA cards. It's fast and deadly... if you get crunched by an asteroid, you suck vacuum. This version corrects the incompatibilities many users encountered with the one previously offered on our almost free software disks.

FROGGER is a PC version of the classic arcade game. Try to get your frog across the road without him winding up splattered by the traffic. Less messy than real life. Requires a CGA or EGA card.

HAUNT is a text based adventure game in which you attempt to work your way through a haunted house. It's quite a large house, though, with an endless plethora of rooms and objects.

LINKFOUR is a computerized version of the popular Connect Four vertical checkers game. Try to get four coloured dots in a row before the computer does. It's a classic puzzle. Requires a CGA or EGA card.

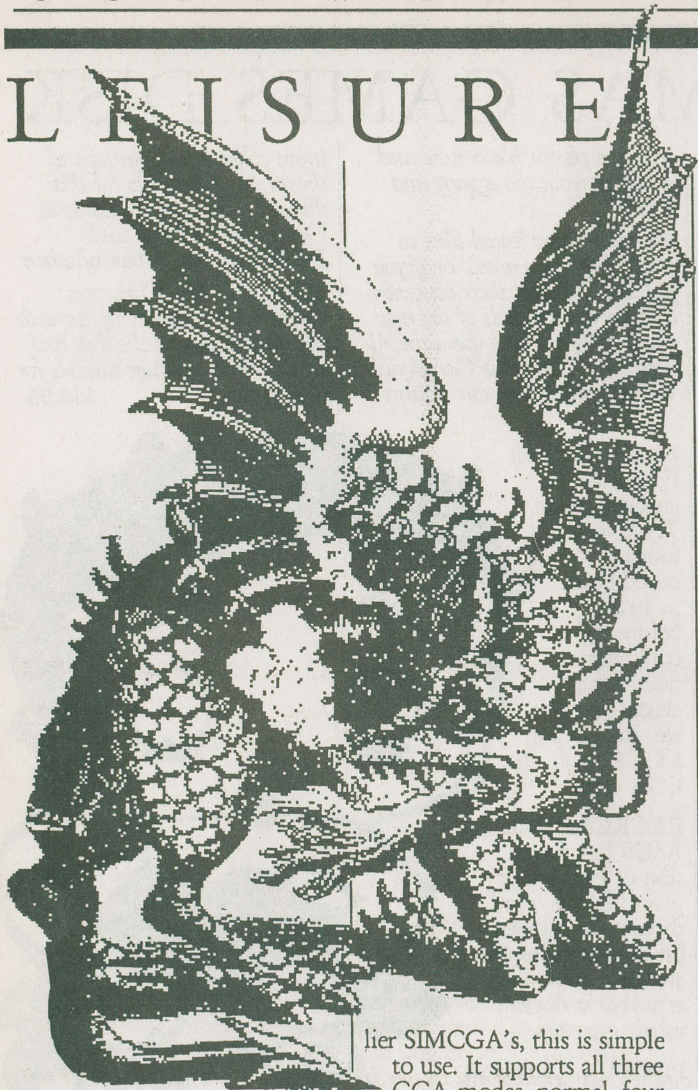
PACKGAL is an ASCII based version of PacMan. It plays like the wind, though, and is every bit as exciting as the arcade version... except that it doesn't inhale quarters.

PINBALL2 simulates the action of a pinball machine on your computer. This one has all sorts of traditional pinball phenomona, including flippers, out lanes, kickers, gates and so on. Requires a CGA or EGA card.

TREK lets you tear through space meeting interesting new life forms and slaughtering them. It's a complex graphic space game with lots of action and even a plot of sorts. There's no blood like green blood. Requires a CGA or EGA card.

WILLY is the strange and wonderful saga of willy the worm. In this episode, you get to help Willy go home. Willy is a graphic arcade game clearly written by someone a little warped. Requires a CGA or EGA card.

LEISURE LIBRARY



VOLUME 1
COLOUR CARD PROGRAMS

AQUARIUM make your monitor a fish tank which cannot spill onto your computer. Good for endless hours of meditation. CGA is required.

MSLIFE or more fully, the game of life for Microsoft Windows. A mouse is almost vital for setting up screens. This version has some nice features, including constant update of the MSLIFE icon.

AIRPLANE allows one to display and print blueprints for paper airplanes. Great for office mayhem. CGA and BASICA or GWBASIC are required.

SIMCGA version 4.0, the latest we've found. As with earlier SIMCGA's, this is simple to use. It supports all three CGA modes, normal, fourty column, and hi-res mono mode. All the CGA programs on this disk worked for us with SIMCGA.

HELPME cannot be described. If it does not startle, perhaps even scare people around you, find some people to show it to. Run it and listen to what happens!

SAYTIME basically just says the time. This is a resident program which will cause your system to speak the current time whenever the correct key code is entered, even when you are in another application. Great if you can't see a clock and your screen is too full for an on screen one.

CALLTIME should only be used by Torontonians. It calls Toronto's own radium clock, and grabs the time correct to the second, then installs it on your system. If you have an AT, it even installs it in the battery supported CMOS. Requires a modem connected to an outside line which can call central Toronto without long distance fees. Version 3.1.

PLANETS computes information relating to the position, distance, magnitude, and so on for the major planets in our solar system on a specific date and time. A must for space travellers. CGA required for graphic displays.

MELT clears your screen slowly. Sort of. This is the type of program which makes DOS's CLS command so ghastly boring. CGA is required.

DAZE This too, is a little weird. An excellent way to leave an unused computer, this colour demonstration leaves accounts receivables in the dust! CGA required.

WHIZ cleans the inner surface of your monitor with electron brushes already available to users who have CGA compatible systems. Great for that one glaring hard to get at place.

JOYCAL is a slick joystick calibration system specially designed for those with...you guessed it...joysticks. It will support both joysticks simultaneously, calculate the centre, then tell you how to adjust your stick.

DRSLEEP, Dr. Sleeptite and the Nightmare Factory is a strange experience. Get fifty thousand volts through your body, be attacked by killer pillows, and above all, avoid sleep. The mad doctor is at it again. This game requires CGA.

$19.95

VOLUME 2
EGA PROGRAMS

MONALISA is the lady herself. The picture is drawn slowly but accurately. EGA required.

EGAD is one of the most impressive EGA demonstrations around. It has everything from flickering photos to QIX lines to a multi- shape kaleidoscope in full colour. Supports mice and exploding boxes.

EGAWAL is creates complex geometric patterns on EGA the screen. Run this and stand back and watch! Another great one for bored machines.

ROSES creates similar EGA patterns to EGAWAL, however, it creates them faster and makes them look more like flowers. The originality of program names is astounding, no?

EGASNO simulates a snowfall in EGA. You may adjust the speed at which snow falls as well as the amount of snow actually coming down. This program is altogether unuseful, but is great for getting an idea of the absolute limits of EGA's resolution.

MGGS stands for Mandelbrot Graphics Generation System. This gem of a set of programs calculates Mandelbrot images and displays them on either CGA or EGA systems. Calculations may be done with a math co-processor if you have one installed. Version 3.2.

FRACLAND draws landscapes, shorelines and islands shaped by fractal geometry. Interesting, realistic, and BASIC source code is even included. CGA is required.

AUTUMN displays autumn colours and leaf-pile designs which are also created using fractal geometry. Source code is unavailable. CGA required.

TEAPOT is an EGA demonstration of three dimensional graphic rotation abilities. Use the cursor pad to decide which direction and on which axis your teapot will spin and from where you will observe it.

ROLEX is a giant screen sized EGA watch face which keeps accurate time, assuming your system clock keeps accurate time. Also includes the date as an added bonus. This program could be useful in offices where spare computers outnumbered spare clocks.

LINES is a collection of commands to determine how many lines your screen will keep in EGA. Select 15, 25, 35, 43, 50, or 60. Also included is a command to give you 120 columns. Works only with EGA.

EGA2RAM takes IBM EGA BIOS and stores it in RAM, then tells the computer to refer to the RAM copy of the BIOS instead of the ROM. This speeds up many EGA screen writes, since RAM is much faster than ROM. Assembler source is included.

ATI2RAM is the same sort of thing as EGA2RAM, but it works with ATI's EGA Wonder BIOS instead of IBM EGA. Speed increases can be anywhere from fifty to one hundred percent, depending on whether the software makes direct memory writes or actually uses BIOS.

$19.95

VOLUME 3
GRAFICS & GAMES

EGA2GIF is a memory resident utility which grabs EGA screens when you hit the key combination, and stores them on disk.

VGIF, a GIF picture viewer in EGA, can also convert GIF pictures to formats used by various paint programs, including EGAPaint, PC Paintbrush, etc. Also allows for slide shows of pictures. Included are three GIF pictures to start your own slide show.

XONIX is a fast paced game of luck and mental coordination. This is perhaps one of the most addictive games around. CGA required.

ALDO is a game which was created specifically for AT286 machines with 256K EGA cards inside 'em. It's basically a Donkey Kong clone, with really smooth graphics.

DALEKS will be a natural to all Dr. Who fans. The object of the game is simple....smash as many of the robots as you possibly can before getting killed.

PITFALL is a simple but fun exercise in futility. You are dodging the walls of a pit as you fall deeper and deeper. Trouble is, the pit gets narrower the farther you go.

MUMMIES is a simple low resolution game which is actually quite similar to DALEKS. While exploring the tomb of the ancient King Mut, you are beset upon by hoards of mummies. Wonderful topic for a computer game, but it is fun.

SCRABBLE is Scrabble. This one is in EGA, knows all the rules, and even keeps score for you. Definitely a classic computer game, even if it can't play against you.

CHESS is a very small chess player, rather fast, not impossible to beat. CGA is used, and the pieces are made of not wood or metal, but realistic graphics. Small enough to fit in a pocket, it's just the thing to while the time away when you should be word processing. **$19.95**

CLIP ART
FOR PC/XT/AT AND MACINTOSH

Digital clip art is the spice of desktop publishing, as well as being useful for other applications and just fun to meddle with. However, unless you have a scanner and a source of interesting original art, you'll have a hard time amassing a library of images. We've taken a lot of the waiting and fiddling out of using clip art with these collections.

These volumes consist of collections of image files in the MacPaint file format. The IBM PC versions include a utility to convert them to GEM/IMG paint files, to make them more readily useable with the popular Ventura Publisher package. The Macintosh versions are all set to be included in documents created by MacWrite, Word, Quark, PageMaker, Ready Set Go and other Macintosh applications.

These files are the cream of public domain images...we sorted through over eight megabytes of pictures to bring you these two disks. They include spot illustrations, full page picures, cartoons, scanned art and all manner of ornaments and dingbats. While the MacPaint format is typically reproduced as seventy five dot per inch pictures which occupy a full page, under Ventura you can use these pictures as true three hundred dot per inch art, in which case the images occupy about two by three inches unscaled.

If you use desktop publishing, you won't want to be without our clip art collections. All of the stray images in this catalog have been drawn from the following collections.

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If you use Ventura publisher or any application which drives a Hewlett Packard LaserJet Plus compatible printer, you will certainly have experienced the lack of interesting fonts available with most commercial programs. Desktop publishing is really a bore if you can't drag yourself out of the usual mire of Times and Helvetica and sing once in a while.

Now you can. Almost free LaserJet soft fonts are collections of decorative headline faces to dress up your documents. They can be used with any application which talks to a LaserJet compatible printer. However, because of the popularity of the Ventura publisher package, we've included a width table generator for each collection which will painlessly integrate these fonts into Ventura for you.

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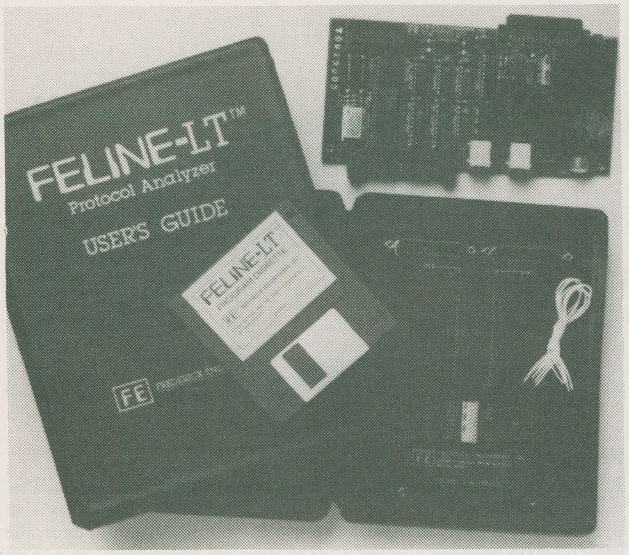

Feline-LT

The Frederick Feline-Lt is a dataline monitor/protocol analyzer on a half-card that plugs into a Toshiba Model 1100+ or 3100 lap- top. Feline-LT handles such protocols as X.25, SNA, HDLC, and BSC. ASCII, EBCDIC, CRC-CCITT, CRC-16, CRC-12, CRC-6, LRC and parity error checking. State analysis, triggering, timers, counters and analysis programming are standard. Feline-LT includes a half-size board that plugs into the Toshiba Software User's Guide and RS-232 Interface Pod. Represented in Canada by Atelco Inc.

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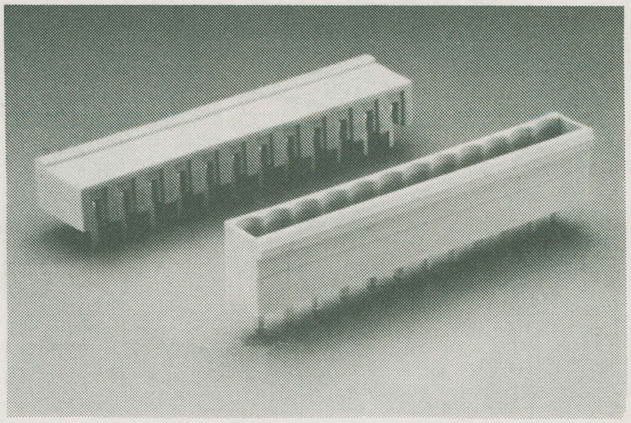

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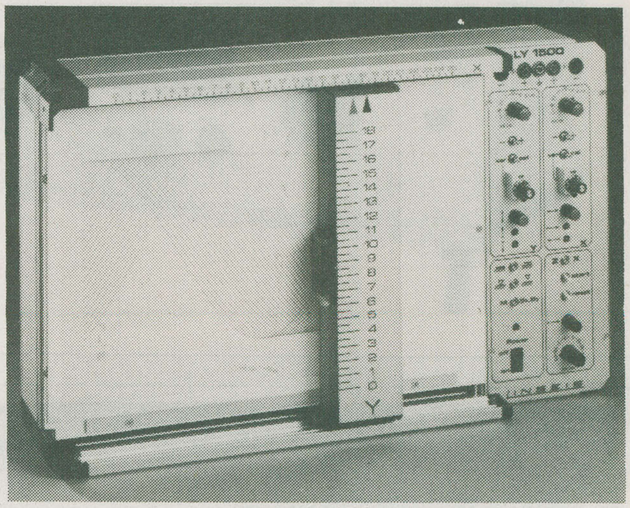

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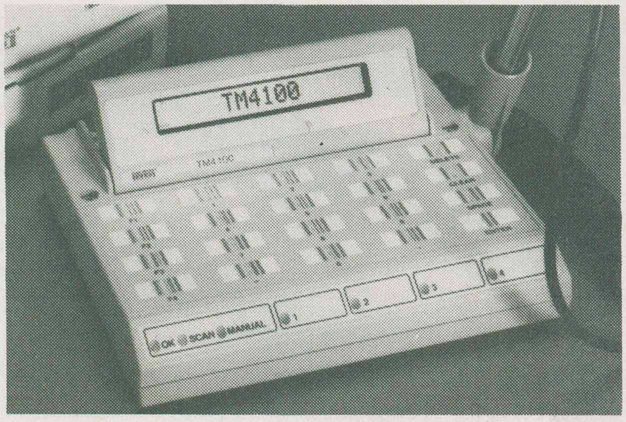

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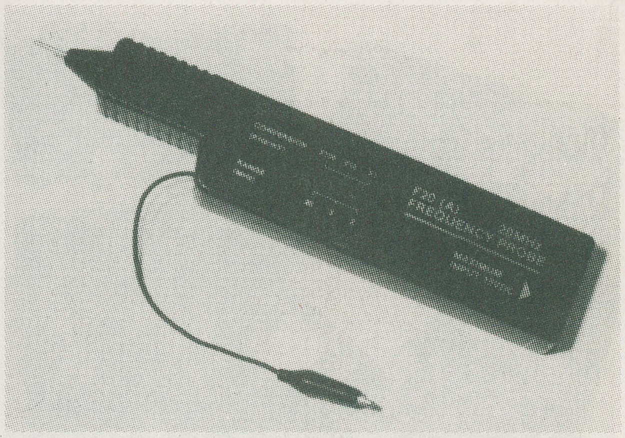

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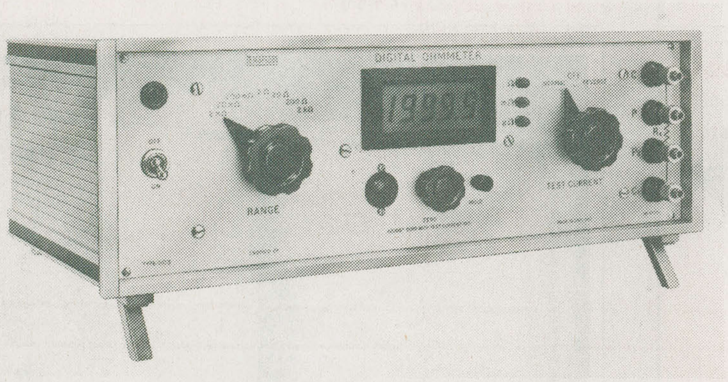

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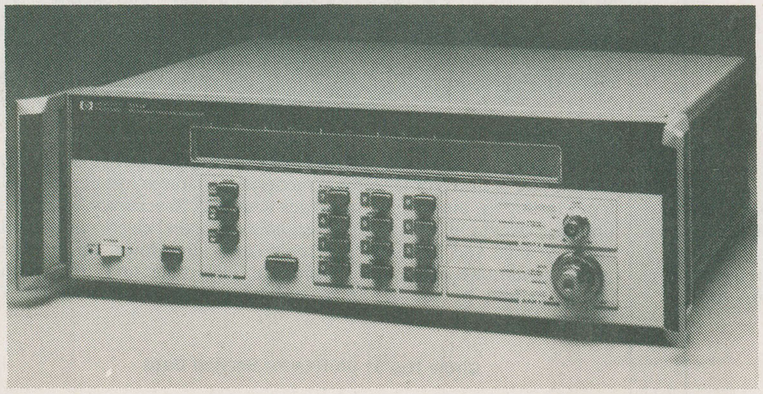

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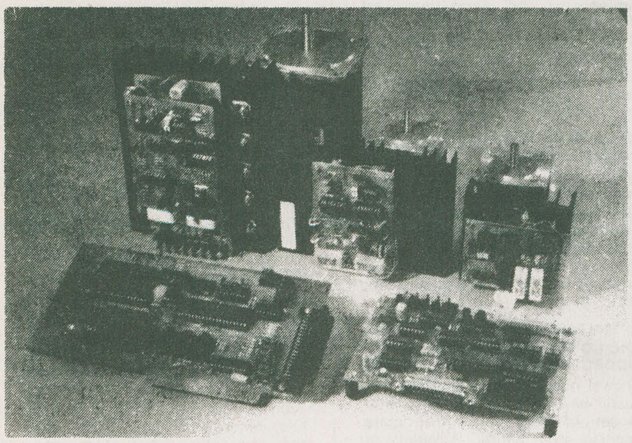

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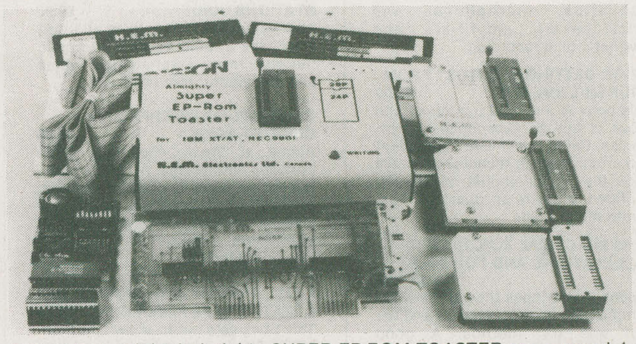

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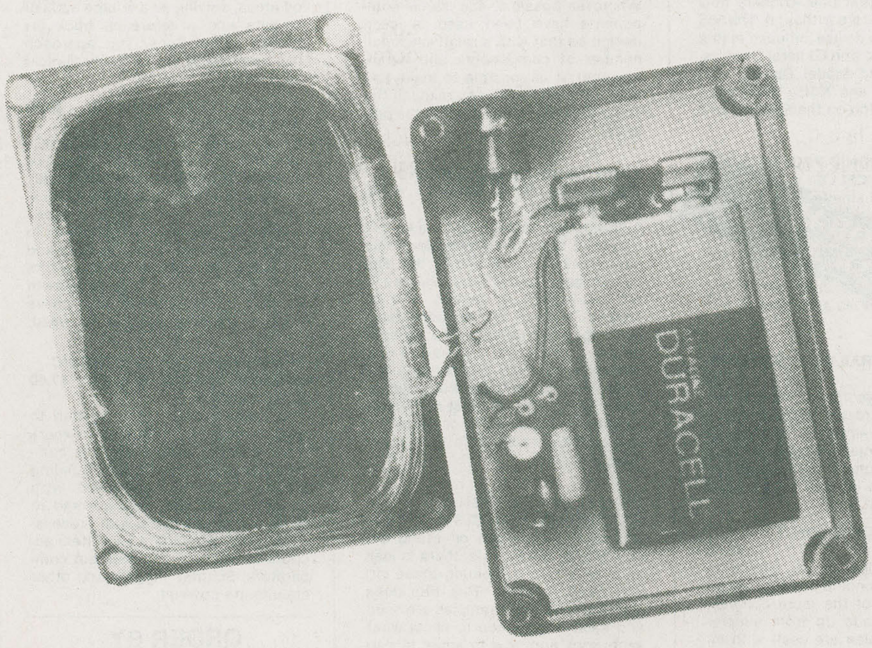
Simple Metal Detector

Find buried treasure and avoid nailing through the water pipes with this simple but effective metal detector.

KEITH BRINDLEY



Although this metal detector is certainly small, it does require a few extras. You don't need a car battery for power, a backpack (to put it all in) and a six foot dipole antenna to make the project work, but you do need a small transistor radio. The metal detector works by transmitting a weak radio wave carrier signal around itself, which has to be picked up with a nearby radio.

The carrier signal main frequency is in the vicinity of the lower end of the longwave band (around 120kHz) and is of sufficient strength to interfere with a radio within about a foot or so. The interference is heard as a whistle from the radio's loud speaker. As the whistle changes frequency, you know the metal detector is approaching a metal or metal-like object.

Sensitivity is pretty good considering how simple the project is. With a remote pickup coil metals can be detected from a distance of six inches or so. Even when the pickup coil is mounted on the project's case (as ours is) metals can be detected from around three or four inches.

How It Works

The circuit is a Colpitts oscillator, formed around transistor Q1 which is connected to a common base amplifier. Positive feedback is applied from the collector to the emitter via the AC potential divider formed by the series connected capacitor C2 and C3.

Capacitors C2 and C3 also form one arm of a parallel LC circuit. The circuit's resonant frequency is given by the relationship

$$f = \frac{1}{2\pi\sqrt{(LC)}}$$

and is around 120kHz. Conversely, we can calculate from the relationship that the coil inductance is around 0.88mH. Try it for yourself.

Coupled in this way, the transmitter amplifier becomes a weak radio transmitter, transmitting a carrier wave frequency of around 120kHz. Now this is actually slightly below the frequencies which are normally found on the radio dial (usually 550kHz to 1600kHz). This means that if the metal detector's transmitted carrier were pure, radios could not be used to pick up the oscillations. Fortunately, oscillations are not of a pure sine wave nature, so many harmonics of the resonant frequency are also formed, going right up through the long and medium wavebands and beyond.

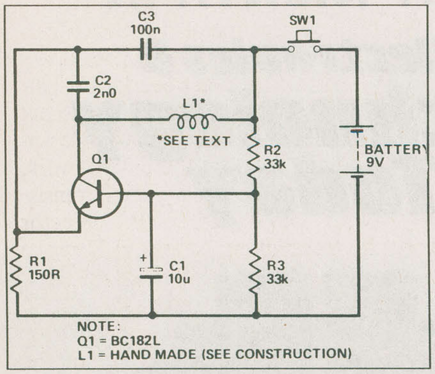


Fig.1 Circuit diagram of the metal detector.

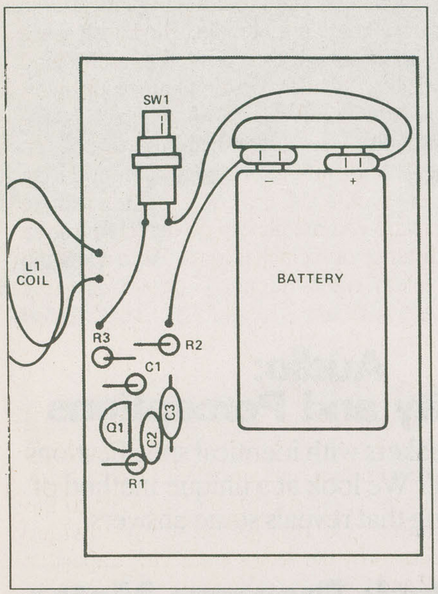


Fig.2 The component overlay for the metal detector PCB.

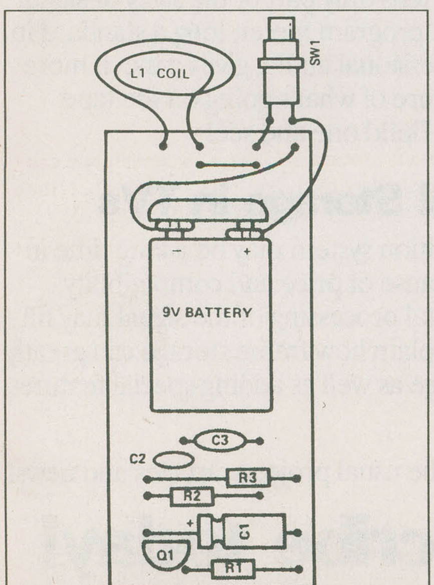


Fig.3 Stripboard component overlay. Note there are no track cuts required for this design.

The project functions as a metal detector simply because the actual inductance of the resonant frequency's coil varies with the proximity of local metallic bodies. Ferromagnetic bodies particularly concentrate the magnetic flux within the coil, so increasing the coil's inductance and lowering the resonant frequency of the oscillator.

A local transistor radio is used to pick up the weak carrier signals produced by the metal detector, along with a carrier wave of another radio transmission (of a broadcast nature). The two carriers heterodyne (interfere) to produce an audible beat frequency from the transistor's loud speaker. The beat tone is stable, until a metal object approaches the detector's coil. Then the coil's inductance varies, causing the resonant oscillation frequency to vary and in turn causing the beat tone to vary. So the user hears, simply by a change of the beat's tone pitch, that the coil is somewhere near a metal object.

Construction

Two ways are suggested to build this project – either on PCB or stripboard. Both methods are straightforward and apart from a few points are more or less self-explanatory.

On PCB, construction needn't follow any particular order, although it's probably best to leave the transistor until last. Whatever, go easy on the heat. Solder only one leg of each component at a time, then leave the component to cool before moving on to solder the next leg.

On stripboard it's probably best to stick to a conventional order, still maintaining heat precautions. Insert and solder the single wire link, followed by resistors, capacitors, and the flying leads to peripheral components. Lastly, insert the transistor Q1 and, when you've made it, the coil.

Whichever construction method you choose, check that no unwanted solder links or bridges are present between component leads.

The coil L1 needs to be wound. First, find a former on which to wind it – something of an external circumference of about 220mm, although this measurement is by no means critical. For reference, we used the widest part of a 250ml. bottle of baby lotion. Alternately, a piece of thick card about 110mm long could be used to hand-wind the coil. Make 100 turns of 30swg enamel- covered copper wire, leaving sufficient ends to connect between the coil's final position and the PCB.

When you've wound the coil, fasten it together in two or three places around its circumference with tape and slip off its winding former. Adjust its shape to suit.

Before you solder the ends of the coil into the PCB, make sure you scrape off the enamel from the copper wire for about 5mm from each end so they can be soldered. If you are using polyurethane coated insulated copper wire, there is no need to scrape off the insulation as the copper is self-fluxing on application of heat from a soldering iron.

Any suitable size box can be used to house your project, although the PCB is exactly the right size to fit the box used. The only real precaution you need to take is to mount the coil on the outside of the case (if it's on the inside its inductance is fixed primarily by the PCB and associated components, not by metals you wish to detect) or better still, remotely.

Setting Up

Setting up is simplicity itself. Turn on your radio and, while you press the metal detector's push-button on/off switch, adjust the radio's frequency tuning control until you hear a whistle. When you release the push-button the whistle should stop. If not, the whistle isn't caused by the metal detector and you should readjust the radio's frequency tuning control.

Test the metal detector by moving it closer to metal. The whistle from the radio will change frequency. ■

PARTS LIST

Resistors

(all 1/4W, 5%)

R1	150R
R2,R3	33k

Capacitors

C1	10u 16V axial electrolytic
C2	2n2 ceramic
C3	100n ceramic

Semiconductor

Q1	BC182L or 2N3904

Miscellaneous

SW1	Push-to-make
L1	Handmade coil

PCB; case; 9V battery and clip; 30swg enamel covered copper wire for coil L1.

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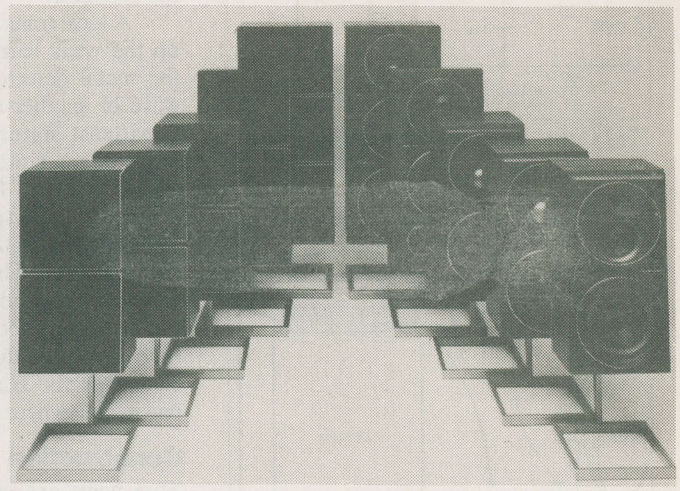

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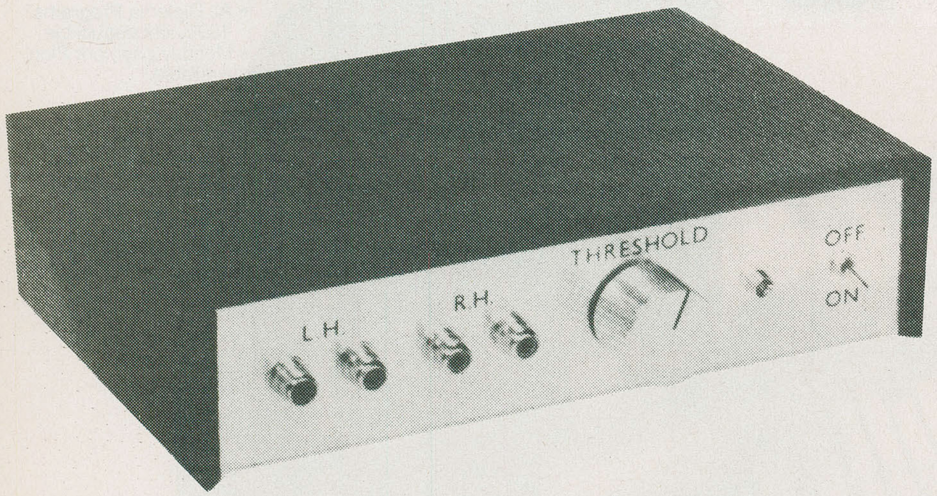
PROJECT

Stereo Noise Gate

Clean up your act and make sure you get your message across to your audience loud and clear.

ROBERT PENFOLD



A noise gate is extremely simple in essence, and the basic idea is to have an electronic switch which enables the input signal to pass through to the output, but cuts the signal path when no signal is present. Units of this type are normally used on signals which contain a fair amount of noise, either in the form of background hiss or mains hum. The noise would tend to be very obtrusive during pauses in the main signal, and switching it out during these periods can therefore make a worthwhile improvement in the subjective quality of the signal.

Noise gates are used in various applications, but are mainly used in communications systems to clean up noisy voice links, or in electronic music systems. In the case of the latter they are often needed to combat the mains hum that is present on the output of some instruments, or which occurs due to ground loops which prove to be difficult to eradicate, but may also be used to combat tape noise or hiss type noise from other sources such as certain types of effects unit.

Noise gates are sometimes utilized as a form of effects unit themselves, and can be used to give an abrupt cutoff to an instrument which has a long decay time. In this role the unit is really operating as an envelope modifier rather than as a noise gate, although it is still the noise gate name which is normally applied to units of this type.

Zero Point Switching

Although simple in theory, some noise gate designs are quite complex. It is one of those things where a basic design can be built using a handful of components, but one which gives really good results needs to be much more involved.

The main problem with very basic types is that they tend to generate switching clicks as they switch on and cut off again. The importance of this depends on the application, but a design which does not generate these glitches will almost invariably sound noticeably better than one which does, and in some electronic music applications the difference can be very noticeable indeed.

There are two main approaches to avoiding the switching glitches, and these are predictive switching and zero point (or crossover) switching. With predictive switching the gate appears to predict that the signal is about to commence, and switches on just before it does so.

What is actually happening is that the

switch is being activated in the normal way by detecting the commencement of the input signal, but the signal to be gated is fed to the switch via a delay line so that the switch has time to close before the signal reaches it. This system can still produce a switching glitch when the signal is cut off, although in most cases the signal is not switched off until it has decayed to a very low level, and any switching glitch is then likely to be so small as to be unnoticeable.

This noise gate design uses the alternative of zero point switching, which is slightly more simple and less expensive to implement, and which seems to give better overall results. With this method it is accepted that by the time the circuit has detected the start of an input signal it will have already reached the electronic switch, but switching glitches are avoided by holding off the switching on of the gate until the signal passes through the zero volts crossover point.

The waveforms shown in Fig. 1 helps to explain the way in which this eliminates the switching clicks. In Fig. 1(a) there is no zero point switching, and the gate actually switches on at the worst possible time, which is at the peak of a half cycle. This gives a signal which rises almost instantly to the peak level, and in doing so it produces strong high frequency components which give the switching click sound.

With a combination of high amplitude and high frequency components this glitch will stand out clearly against most types of signal. Of course, the signal will not always be switched on when it is at or near its peak level, but in practical tests with a variety of signals a simple noise gate was found to generate strong switching glitches far more times than they were very weak or absent.

With the zero point switching waveform of Fig. 1(b) the switch-on has been held off until the end of the half cycle, so that the output signal from the gate starts at the beginning of a half cycle. There is no sudden rise in the signal to a high level, and no click will be evident on the output signal. This system is less than perfect in that a few milliseconds at the beginning of the signal are lost, but in practice it is highly unlikely that this would ever be noticeable.

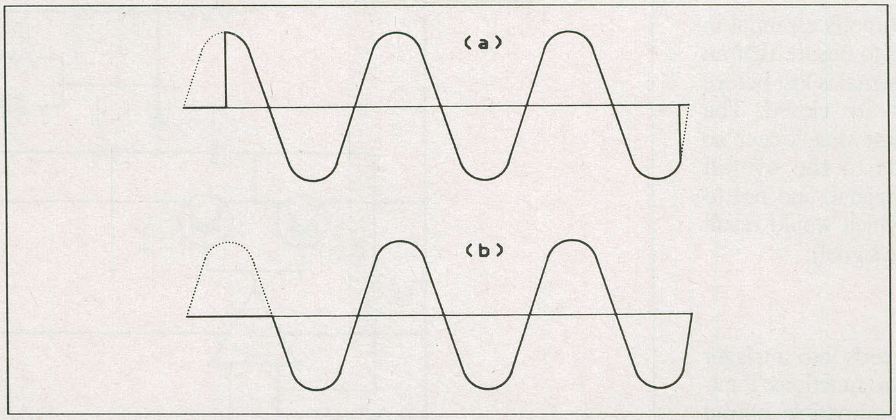


Fig.1. In waveform (a) the signal is cut on and off near its peak level, producing "clicks" that are absent from the waveform shown in (b).

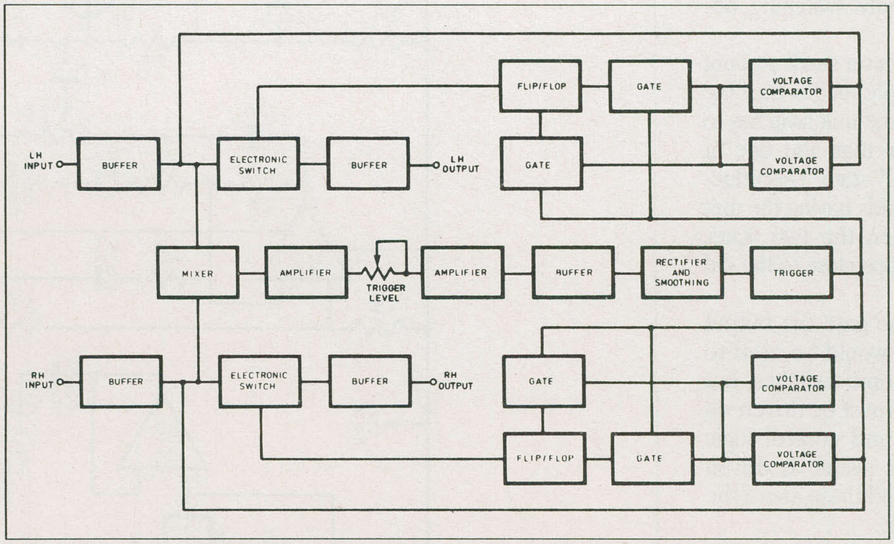


Fig.2. The block diagram for the Stereo Noise Gate. Although it looks quite complex the actual operation is quite straightforward (see text).

Switching glitches can also occur when the signal is switched off again. These are caused by a similar effect, with the output signal suddenly being switched from (possibly) a high amplitude to zero. Often the signal will be at a low level by the time it is switched off, but ideally the zero point switching should also be active at switch-off so that a high cut off threshold can be used if desired, without the risk of any significant switching glitches.

System Operation

The block diagram of Fig. 2 shows the general arrangement utilized in the Stereo Noise Gate, and although this looks rather involved, the basic means of operation is actually quite straightforward.

Each channel has an electronic switch which is used to switch the input signal through to the output, or to block its path, depending on the input signal level. A buffer amplifier ahead of each switch provides the unit with a reasonably high input impedance while a buffer stage following each switch gives the unit a low output impedance.

The basic function the noise gate must provide is to generate a signal to turn on the switches if the input exceeds a certain threshold level, or to switch them off if the signal is below this level. With a stereo noise gate it is normal for the two channels to be switched in unison as the action of the unit becomes much more apparent if they operate independently. Therefore, the output of each input buffer amplifier is coupled to a mixer stage, and the gating signal is derived from the output of the mixer.

With this system there is actually no rigidly defined level at which the gate is activated in the sense that the threshold level is the sum of the input levels, rather than at a certain level on one or other of the inputs. This gives perfectly good results in practice though, and helps to simplify the unit slightly.

Amplifier

It will often be necessary for the gate to be activated at quite low signal levels of around -40dB or less, and a large amount of amplification is needed after the mixer

in order to produce a strong enough signal to drive the switch control circuits properly. Two stages of amplification are used, with a gain control fitted between these two stages. This acts as the trigger level control.

A buffer stage follows the second amplifier, and the purpose of this is to provide a very low output impedance so that the next stage can be driven properly. This stage is a smoothing and rectifier circuit, and the low drive impedance permits a very rapid attack time of under a millisecond to be achieved.

A very fast attack time is essential in this application in order to ensure that an insignificant amount of signal is lost before the electronic switches are closed. The decay time must be somewhat longer so that the unit responds to the overall amplitude of the input signal, and not to individual half cycles (which would result in severe chopping of the signal).

Trigger Levels

The smoothing circuit feeds into a trigger circuit which provides two functions. Firstly, it provides a logic compatible output from the input signal which will be at non-logic voltage levels and will vary relatively slowly rather than cleanly switching between two levels.

Secondly, it introduces a small amount of hysteresis, which simply means that the threshold level at which the unit switches to the "on" state is higher than the one at which it reverts to the "off" state. This reluctance to change state avoids having the unit rapidly switching between the two states when the input signal drops close to the cut off point.

With a simple noise gate the output from the trigger circuit would be used to directly drive the electronic switches, but in this case the switches must be driven via zero crossing detector and control logic circuits. Each electronic switch is driven from a flip/flop circuit, and these are of the basic S/R (set/reset) type.

A flip/flop of this type has two inputs called the "set" and "reset" inputs, and there are two outputs called the "Q" and "not Q" outputs. The outputs always have the opposite states to one another, and in this case only the Q outputs are used. These are set high by a positive pulse to the set input, and set low again by a positive pulse to the reset input. In this case, the set pulses close the electronic switch, and the reset pulses open it again.

Voltage Comparator

Two voltage comparators provide zero

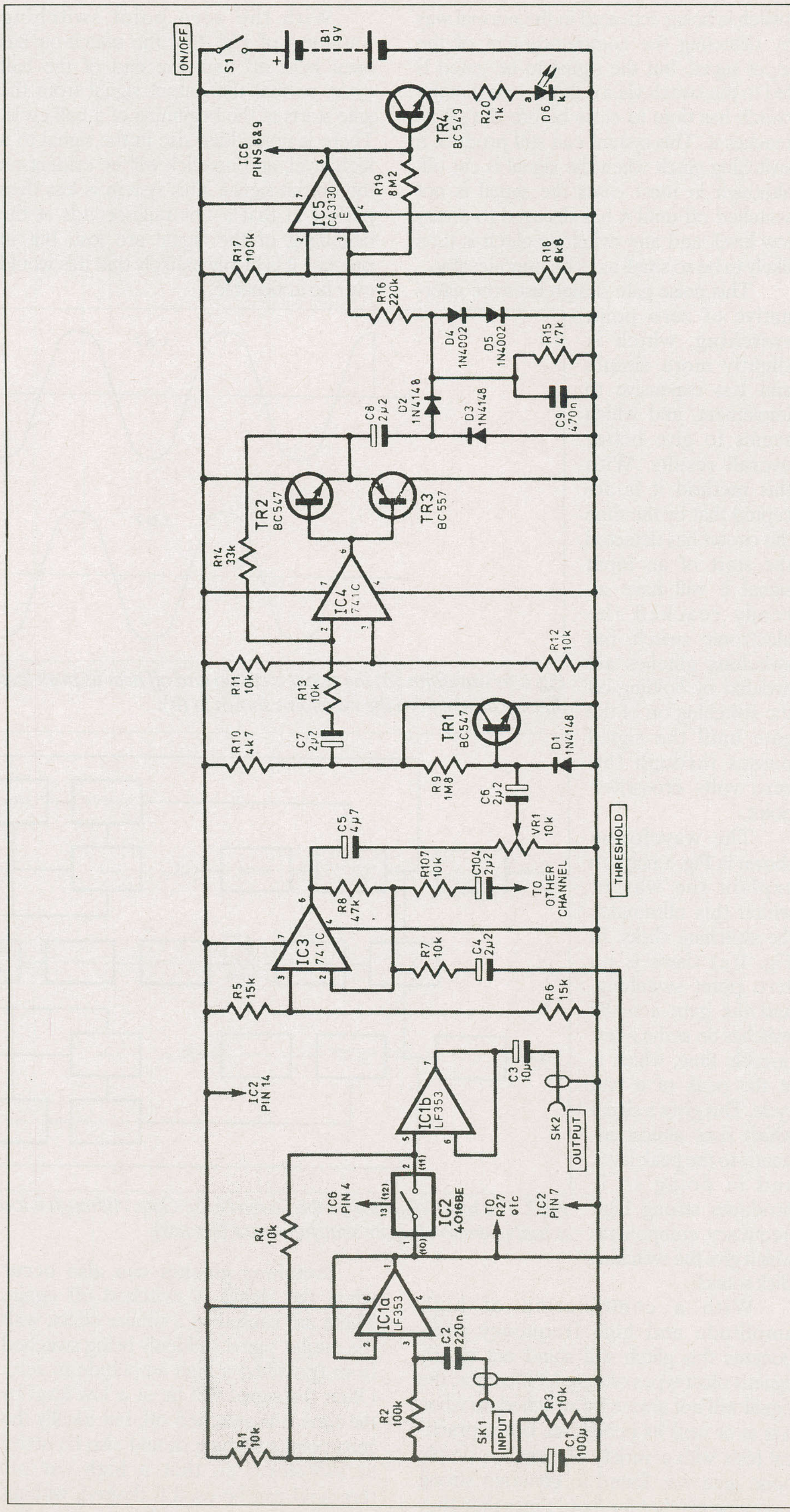


Fig.3. The main cicuit diagram for the Stereo Noise Gate.

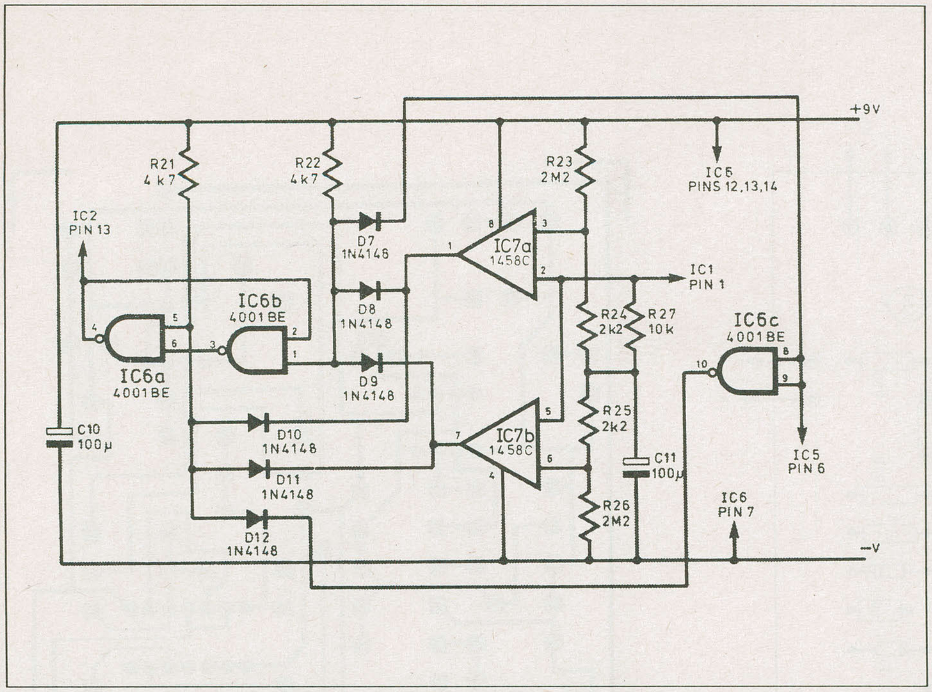


Fig.4. Circuit diagram for the zero crossing detector, gate and flip/flop stages. This circuit is repeated for the stereo channel.

crossing detection, and these are set up in such a way that both their outputs go high if the input voltage is within a few millivolts of zero volts. The two outputs are fed to a gate circuit, along with the output from the trigger circuit.

The gate is designed to provide a positive output only if all three inputs are high, and it provides the set signal for the flip/flop. In other words, the desired action is obtained, with the trigger output going high, but the electronic switch not being activated until the signal reaches the zero crossover point and the outputs of both comparators go high as well.

The reset pulse is produced by a second gate circuit, and it is fed from the same sources. However, it differs from the other gate in that it generates a high output level when the outputs of the voltage comparators are high, and the trigger outputs is low (not high). Thus the electronic switch is turned off when the trigger output goes low, but only when the comparators detect that the input signal has entered the zero crossing zone.

As the signal in each channel will normally be different, a separate zero crossing detector and control logic circuit is needed for each channel. This means that the two channels will not be switched precisely in unison except when the two signals just happen to pass through the zero point simultaneously. However, the time difference between the two channels switching will usually be no more than a few milliseconds, and is unlikely to be noticeable.

Circuit Operation

The main circuit diagram of the Stereo Noise Gate appears in Fig. 3, with the zero crossing detector gate circuit shown separately in Fig. 4. Note that this circuit is for ONE channel only, and that for stereo operation much of the circuitry is duplicated in the second channel.

The input and output buffer amplifiers IC1a and IC1b (Fig. 3) are both standard non-inverting types. The input impedance of the unit is nominally 100k. IC2 is the electronic switch and this is a CMOS 4016BE quad SPST type. One of the four switches is used in the other stereo channel, but the other two are simply ignored.

The input of IC1b must not simply be left floating when IC2 is switched off, as it would almost certainly drift away from the normal bias level, and this would cause a switching click each time the switch was activated. Resistor R4 is therefore used to bias IC1b's input to half the supply voltage during the periods when IC2 is open.

The mixer stage IC3 is a conventional summing mode type. It is designed to have a certain amount of gain, and it therefore doubles as the first of the amplifier stages.

The potentiometer VR1 is the Threshold control, and this feeds into the second amplifier which is a high gain type which has TR1 operating in the common emitter mode. This amplifier will often be considerably overloaded, and diode D1 is needed to prevent this from driving the biasing well off its correct level, which could cause the circuit to occasionally malfunction.

The buffer amplifier uses IC4 in the inverting mode with TR2 and TR3 as a discrete class-B output stage which gives the circuit a high drive current capability. The circuit does exhibit a small amount of voltage gain, but only about 10dB (just over three).

Decay Time

Diodes D2 and D3 are the rectifier circuit, and capacitor C9 is the smoothing capacitor. Resistor R15 sets the decay time, and with the specified value this is quite short (less than 100ms). The decay time can be altered by changing the value of R15 though, or a potentiometer could be used here to give an adjustable decay time. The decay time is proportional to the value of R15.

Diodes D4 and D5 limit the voltage produced across capacitor C9 to no more than about 1.3V, and this helps to give consistent results. Without this limiting some signals would generate a very strong voltage on C9 which would take a long time to fall to the switch-off threshold voltage, and this would give inconsistent decay times.

IC5 operates as the trigger circuit with positive feedback and hysteresis introduced by resistor R19. The LED indicator D6 is driven from the output of IC5 by way of emitter follower buffer TR4, and D6 indicates when the gate has been activated.

Zero Crossing Detector

Focussing our attention on the zero crossing circuit, Fig.4, IC7 is a dual operational amplifier but in this circuit both sections are connected to act as voltage comparators. The resistor/capacitor network (R23 to R27 plus C11) provides suitable reference voltages, but note that the circuit is not strictly speaking a true zero crossing detector. What it is really detecting is when the signal voltages is close to its quiescent bias level, which is about half the supply voltage.

The two gates are both 3-input AND types formed from three diodes and a resistor. In the case of the gate that generates the reset signal, the input that is fed from the trigger circuit's output is preceded by an inverter (IC6c), so that

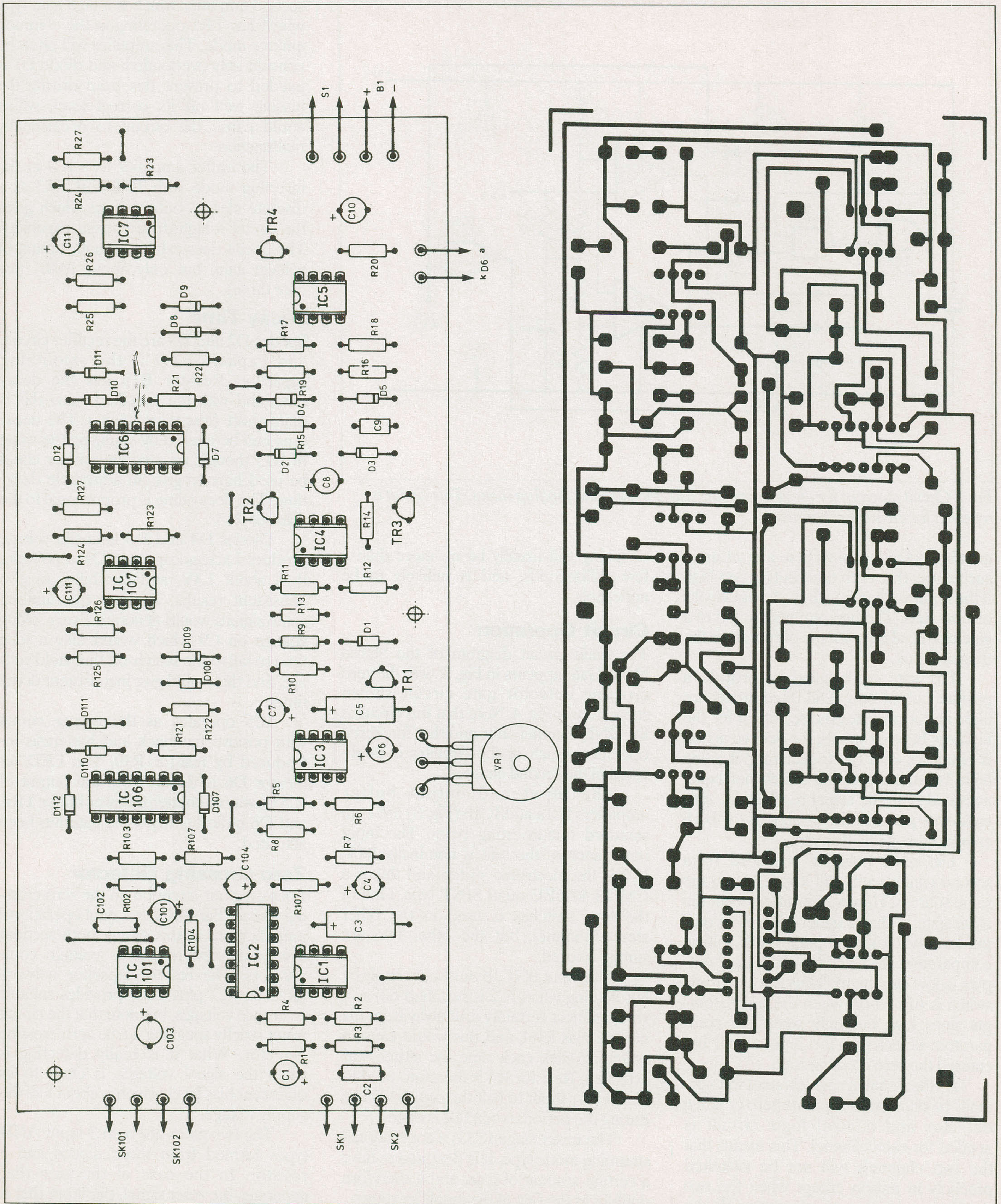


Fig.5. Component layout and full size printed circuit board copper foil master pattern ofor the Stereo Noise Gate. The components with annotations of one hundred added are for the second channel.

when the trigger provides a low output level the input to the gate goes high and generates the reset pulse.

The flip/flop is a conventional CMOS type formed by cross coupling a couple of 2-input NOR gates, IC6a and IC6b. One of the other gates in IC6 is used as the inverter mentioned above, but the other gate is left unused.

The current consumption of the circuit is about 18mA when in the standby state, and around 25mA when activated (and the LED indicator switches on). Power is supplied by a fairly high capacity 9V battery, such as a PP9 type of six HP7 size cells held in a plastic battery holder.

Construction

Apart from the usual off-board components such as the sockets and the controls, the components are all mounted on the printed circuit board, as detailed in Fig. 5. There are quite a few components to fit onto the board, but provided things are taken steadily with no undue rushing there should be little difficulty in constructing the board successfully.

Be careful to fit the electrolytic capacitors and semiconductors the right way around, and bear in mind that IC2, IC5, and IC6 are MOS input types. These require the normal antistatic handling precautions, and the most important one of these is to use sockets for these devices and not to plug them into the circuit board until all other construction is completed.

A number of link wires are required, and these can be made from about 20swg tinned copper wire, or trimmings from the resistor leadouts are suitable if suitable wire is not to hand. Fit pins to the board at the points where connections to the off-board connections will eventually be made.

With this project we are using the convention of having the component numbers in the second stereo channel equal to those in the first channel but with one hundred added. Of course, many of the components in this case are common to both channels, and therefore only appear with the basic indentification numbers. If a monophonic noise gate is required, build up the board in the normal way but omit any components which have identification numbers more than one hundred.

Case

An instrument case having dimensions of about 203mm by 127mm by 51mm is used as the housing for the prototype, but any case of around the same size would probably be equally suitable. Bear in mind though, that the board is almost 190mm wide, and the width dimension of 203mm represents something approaching the minimum that is usable.

The printed circuit board is mounted on the base panel of the case, and I used self-adhesive nylon supports, but obviously conventional mounting pillars or spacers and mounting bolts can be used if preferred. Fit the board well forward so that there is sufficient space for the battery at the rear of the unit, but leave enough room to accommodate front panel mounted components. The sockets specified in the components list are phono types, but an alternative audio connector may well be more convenient with your particular set up, and the sockets should be changed to a more suitable type if necessary.

There is little in the way of hard wiring, and there should be no real problems in completing this. Ideally, the leads from the board to the input and output sockets should be screened, but this is not essential provided these leads are kept reasonably short.

In Use

With the Threshold control VR1 well backed off the effect of the unit should be readily apparent with the signal being coupled through to the output only during a fairly high level. If VR1 is set in a fully anticlockwise direction the signal should be continuously cut off. D6 should switch on and off in sympathy with the signal being cut on and off. With VR1 well backed-off the unit is only really usable as a musical effects unit, and it would not normally be set up in this way for true noise gate applications.

To adjust the unit for use as a noise gate the unit must first have the signal source connected to its input. There should be no signal present through, just the background noise that must be suppressed.

With the Threshold control VR1 well advanced D6 should light up. VR1 should then be backed-off just far enough to switch-off D6, or if D6 does not switch on even with VR1 fully advanced, then VR1 should be left fully advanced.

Subjectively, results might be better with VR1 back-off slightly from the point where the unit only just cuts off the signal before it fully decays. It is worthwhile experimenting a little with the setting of VR1 to determine the setting which gives the best results in practice. ■

PARTS LIST

Resistors

R1,R3,R4,
R7,R11,R12,
R13,R27,R101 .... 10k (3)
R103,R104
R107,R127
R2,R17,R102 .... 100k (3)
R5,R6 .... 15k (2)
R8,R15 .... 47k (2)
R9 1M8
R10,R21,R22
R121,R122 .... 4k7 (5)
R14 33k
R16 220k
R18 6k8
R19 8M2
R20 1k
R23,R26,R123,R126 .... 2m2 (4)
R24,R25,R124,R125 .... 2k2 (4)

All 0.25W 5% carbon

Capacitors

C1,C10,C11
C101,C110 .... 100u elec.10V (5)
C2,C102 .... 220n (2)
C3,C103 .... 10u elec.25V (2)
C4,C6,C7,C8,C104 2u2 elec.63V (5)
C5 .... 4u7 elec.63V
C9 .... 470n

Potentiometer

VR1 .... 10k log.

Semiconductors

IC1,IC101 ....LF353 dual op amp (2)
IC2 ...4016BE CMOS analog switch
IC3,IC$ .... 741 op amp (2)
IC5 .... CA3130E CMOS op amp
IC6
IC1064001BE CMOS NOR gate (2)
IC7,IC107 .....1458c dual op-amp (2)
D1,D2,D3,
D7-D12
D107-D112N4148 silicon diode (15)
D4,D5 .....IN4002 rectifier diode (2)
D6 .... Red panel LED
TR1,TR2 .....BC547,2N3904 npn (2)
TR3 .... 2N3906 pnp
TR4 .... BC549, 2N3904 npn

Miscellaneous

B1 .... Six 1.5V cells
in plastic holder (see text)
SK1,SK2
SK101,SK102 ....Phono socket (4)
S1 .... SPST submin. toggle

Instrument case about 203x127x51mm; printed circuit board; control knob; battery connector (9V type); 8-pin DIP socket (7); 14-pin DIP (3); pins, wire, solder,etc.

Field Effect Transistors

A guide to the basics.

OWEN BISHOP

Field effect transistors, or FETs, are widely used in electronic circuits today and are taking over many of the tasks for which we previously used the bipolar junction transistor. We will look at the difference between the two types, but before we can do that, we must say something about semiconductor junctions.

There are two types of semiconducting material, p-type and n- type. There is not enough space here to go into the nature of these materials, or precisely what their names mean, but the essential point is that something interesting happens when we join p-type with n-type.

The pn junction (Fig.1) is the basis of many semiconductor devices. The simplest of these is the diode which consists of a single pn junction. A diode conducts in only one direction. This is because of the nature of the pn junction. What happens is that when the two types of material are placed in contact, a potential difference appears between them. The n-type has a potential of 0.7V higher than the p-type. Further, on either side of the junction, there appears a depletion zone, a zone in the semiconductors in which there are no carriers of electric charge (*eg*, no electrons).

To make current flow across the junction we apply a voltage greater than 0.7V as in Fig.2. This overcomes the voltage between p-type and n-type, the depletion zone disappears and the diode conducts. It is said to be forward-biased. But if we apply a reverse voltage, the depletion zone simply becomes wider, as in Fig.3. There is no conduction.

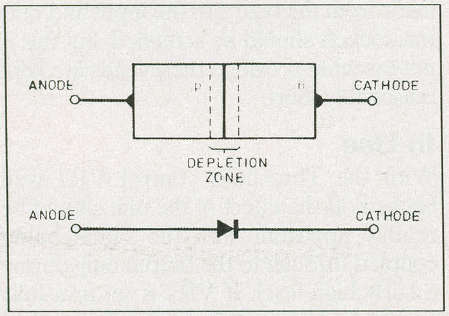


Fig.1. The Diode, diagram and circuit symbol.

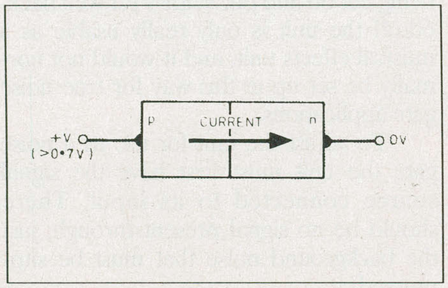


Fig.2. Forward-biased, diode conducts.

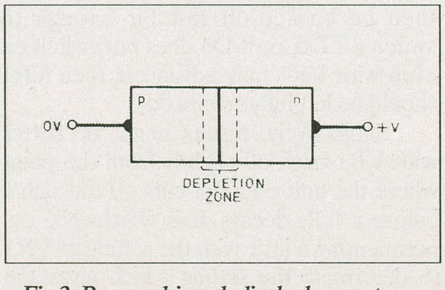


Fig.3. Reverse-biased, diode does not conduct.

Bipolar Junction Transistor

Now we are ready to look at the action of a bipolar junction transistor, Fig.4. The npn transistor (the commonest type used today) has a very thin layer of p-type (the base) sandwiched between two n-type layers (collector and emitter).

Taken together, the base and the emitter form a diode, as do the base and collector. If the base is made positive of the emitter (more than 0.7V), current flows in at the base and out at the emitter.

It might be thought that it is impossible for any current to flow from collector to emitter, since the collector-based diode would be reversed-biased. However, because the base layer is so thin, quite the opposite occurs. As Fig.4 shows, when a small base current IB flows from the base to emitter and the collector is a few volts positive of the emitter, it causes a much larger collector current IC to flow from collector to emitter.

Electronic Switch

By turning the base current on or off, we can turn the collector current on and off—the transistor works as a switch. Since the collector current is much bigger than the base current (20- 200 times) we can also use the transistor as a current amplifier.

Field Effect Transistor (FET)

The FET works in an entirely different way. Fig.5 shows it to be a single bar of semiconductor material (n-type in this example, but it could be p-type). Current flows freely along the bar of n-type material. Normally one end, the drain, is

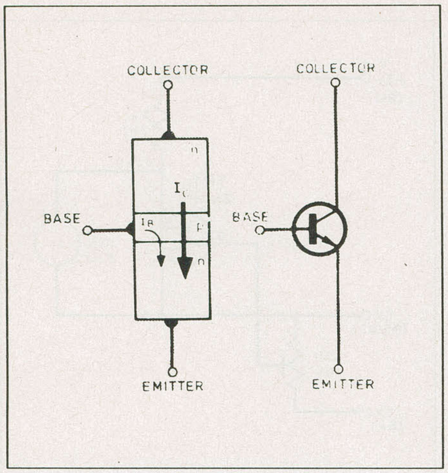


Fig.4. Bipolar junction transistor, diagram and circuit symbol.

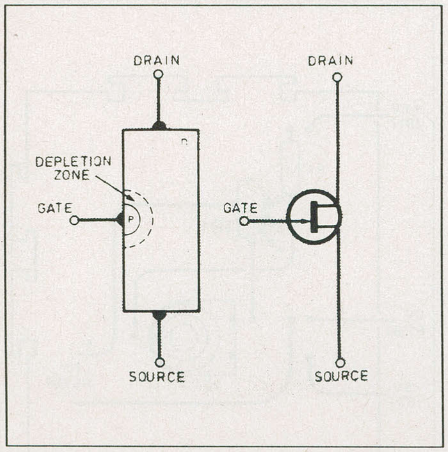


Fig.5. Junction FET, diagram and circuit symbol.

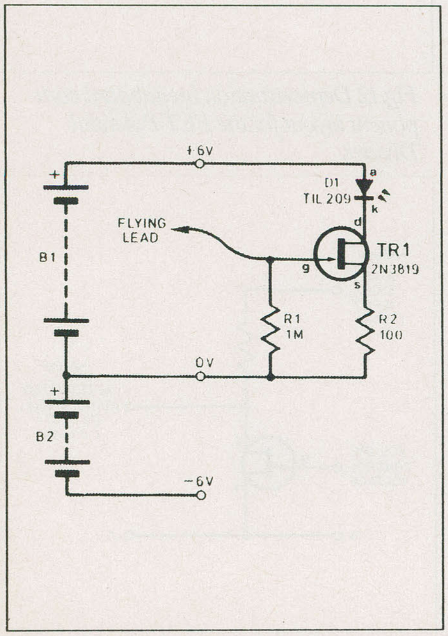


Fig.6. Circuit diagram demonstrating switching action of an FET.

made positive of the other end, the source, so electrons flow from the source to the drain.

To one side of the bar is a small region of p-type material, the gate. This is surrounded by a depletion zone , as explained above. The depletion zone insulates the gate from the drain and the source.

If the gate is at zero volts (with respect to the source) the depletion zone is small. Electrons cannot flow through this zone, so it restricts the flow of electrons along the bar, but not unduly. However, is the gate is made negative of the source, the gate and n-type material are equivalent to a reverse-biased diode. The more negative we make the gate, the wider the depletion zone becomes. The conducting region of the bar gradually becomes pinched off, reducing the current along the bar. If the gate is made negative enough, the depletion zone extends right across the bar and no current can flow.

The action of this type of transistor depends not on the flow of current (such as the base current of a bipolar transistor) but on the effect of the electric field caused by the potential of the gate. This is why it is called a field effect transistor.

FET Switch

A circuit to demonstrate the switching action of a FET is shown Fig.6. The LED D1 is used to show wether or not current is flowing through the FET. The demonstration breadboard component layout for the FET switch is shown in Fig.7.

With the flying lead unconnected,

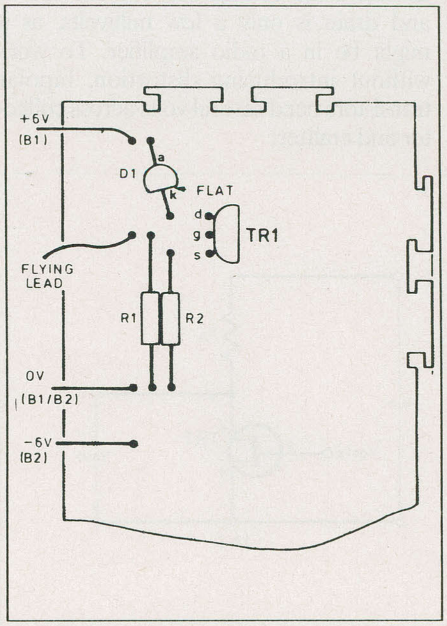


Fig.7. Demonstration breadboard component layout for the FET Switch..

resistor R1 brings the gate potential to 0V. With the lead unconnected, the LED is on.

Now touch the flying lead to the -6V terminal. The negative voltage at the gate, makes the depletion zone so wide that the drain-source current is pinched off. The LED goes out.

Like the bipolar transistor, the FET can be used as a switch. It has the advantage that its switching action is very fast. It has another advantage that becomes apparent in our next demonstration.

A simple FET Touch Switch circuit diagram is shown Fig.8. The circuit has the gate connected by a short lead to a small metallic touch plate. This could be a thumb tack pushed into a piece of wood.

The demonstration breadboard component layout for the simple FET Touch Switch is shown Fig.9. Switch on the power and note that the LED is off.

Now touch the touch-plate with your finger. It is obvious that the amount of current that passes between you and the gate is extremely minute. Yet the act of touching the plate is enough to turn the LED on.

Normally, the touch plate and the gate have a potential about 0.7V below that of the rest of the transistor. Your body has a potential somewhat higher than this. This is due to the fact that you are surrounded by electromagnetic fields generated by the alternating currents flowing in wires in your house, or in the power lines outside. Add to this the effect of friction as you move around, and you finish up with a potential relatively higher than that of the gate.

When you touch the plate, a minute current flows for an instant. The potential of the gate is raised, the depletion zone decreases and the FET becomes more conductive.

Increased current flows through resistor R1 and the potential at point A (Fig.8) rises. This causes an increased base current to flow from A to TR2, turning TR2 on and causing the LED to light.

This investigation shows that the amount of current needed to operate FET is virtually nil. Such a device is ideal for use in logic circuits where thousands of transistors have to be switched on perhaps millions of times a second. The saving of power is enormous.

Before leaving this circuit, try wiring up the touch plate with a longer lead, say 20cm long. Explain the effect of this change.

Now substitute a short piece of insulated wire, stripping at both ends, as the touch plate. Try the effect of touching the bare end. The effect of touching the insulated part of the wire. Can you explain

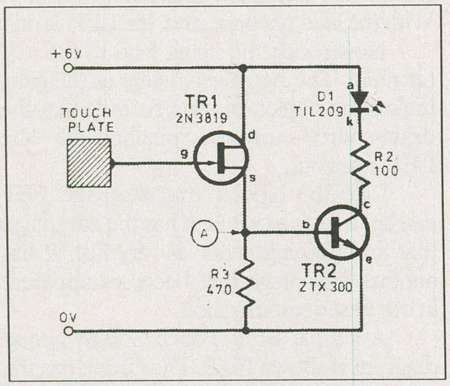


Fig.8. Circuit diagram for a simple Touch Switch. The touch plate can be a metal thumb tack or a piece of stripboard, with tracks interconnected.

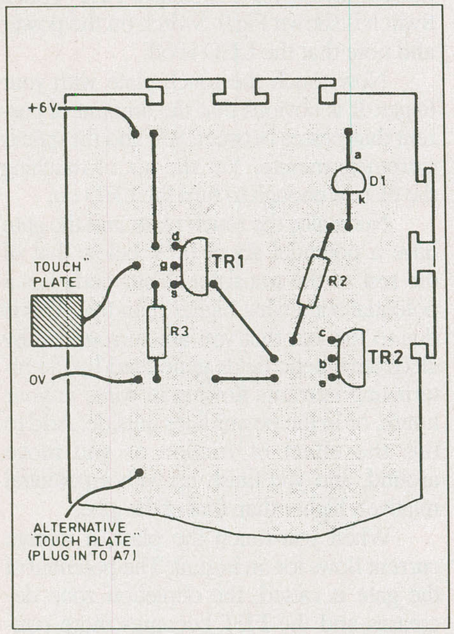


Fig.9 Demonstration breadboard component layout for the FET Touch Switch.

what is happening?

Voltage-Controlled Resistor

The bar of n-type material in FET has a resistance which varies according to the width of the depletion zone. The width depends on the gate potential. Thus we have a resistor whose resistance is controllable by its gate potential.

How this property may be used is shown in Fig.10 Fig.10a is that well known configuration of resistors—the potential divider. Vin is related to Vout like this:

$$\text{Vout} = \frac{\text{Vin} + \text{RB}}{\text{RA} + \text{RB}}$$

If either or both of the resistors are variable, Vout can be varied. Fig.10b shows a circuit using a FET in place of RB. A variable negative voltage is applied to the gate. A typical circuit diagram for a FET potential divider is shown in Fig.11. To demonstrate this circuit, connect the components on the breadboard as shown in Fig.12 and see what happens.

This type of circuit has many applications as a voltage- controlled attenuator. You have probably used a remote-controller to adjust the volume on a TV set. At some stage in the sound amplifier, the sound signal passes through such an attenuator. The attenuator is controlled by a voltage from the remote receiver IC (Fig.13).

Although it is possible to construct an attenuator from bipolar transistors, FETs are better. This is because they work just as well if the voltage between the source and drain is only a few millivolts, as it might be in a radio amplifier. To work without introducing distortion, bipolar transistors need several volts across collector and emitter.

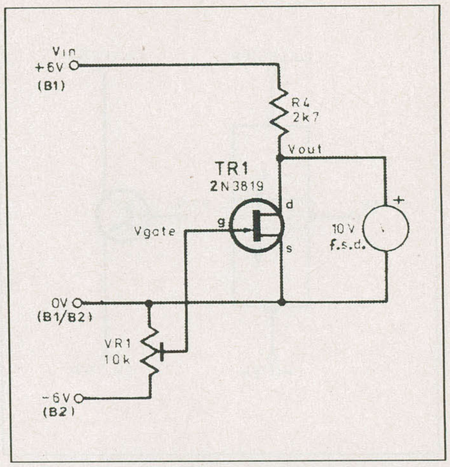


Fig.11 Demonstration FET Potential Divider circuit diagram.

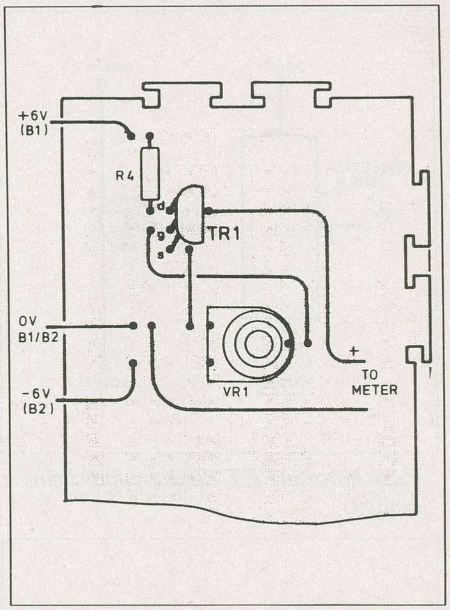


Fig.12 Demonstration breadboard component layout for the FET Potential Divider.

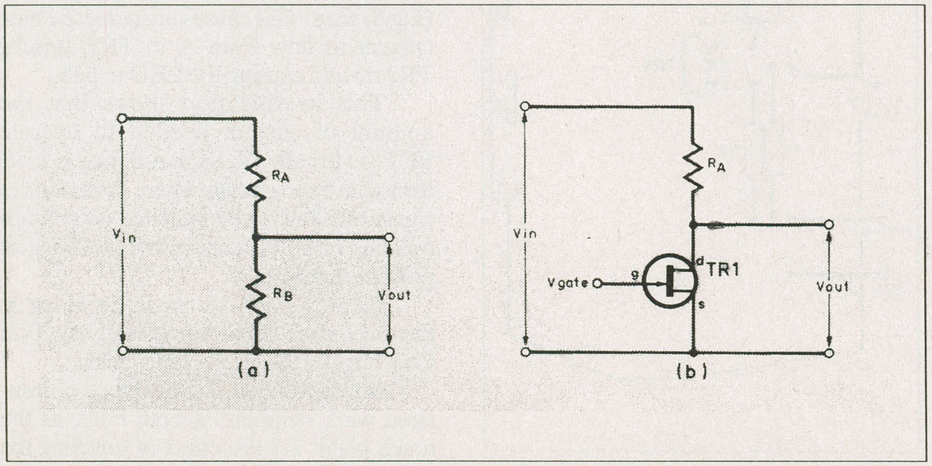


Fig.10 (a) Standard potential-divider circuit and (b) FET potential divider circuit.

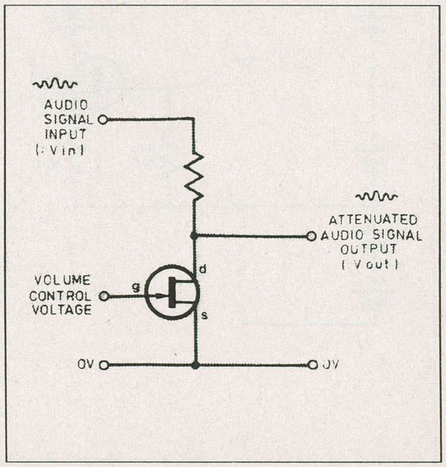


Fig.13. Using a voltage-controlled attenuator.

PARTS LIST

Resistors

R1	1M
R2	100
R3	470
R4	2k7

All 0.25W 5% carbon

Potentiometer

VR1 .... 10k submin. horiz. trim

Semiconductors

D1	TIL209 red l.e.d.
TR1	2N3819 n-channel FET
TR2	2N3904 npn transistor

Miscellaneous

Breadboard; B1, B2 6V battery and connectors (2); materials for touch plate (see text); connecting wire and voltmeter (multimeter), set to 10V f.s.d. scale.

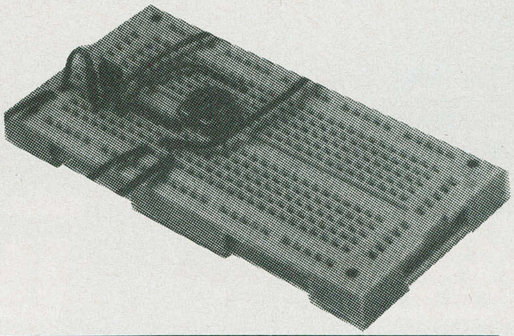
Other FETS

The MOSFETs (FETs based on CMOS technology) are widely used both as individual transistors or as integrated circuits. In the more popular types, the gate controlled by positive voltages, obviating the need to have a negative supply.

In logic circuits MOSFETs have the great advantage that they use virtually no current except when they are actually changing state from on to off. As transistor switches (used similarly to the FET in Fig.6), they can be used to switch analog signals under logic control.

Readers may have heard mention of the Darlington pair, a configuration of two bipolar transistors connected to obtain very high gain. Last, but no means least, are the VMOS transistors. These are MOSFET power transistors, capable of handling currents of several amps, up to 30A or more for the heftier members of the group.

It is obvious that FETs cover the complete spectrum of transistor functions. With the advantages that we have discussed above, it is not surprising that they are being used in an increasing number of applications. ■



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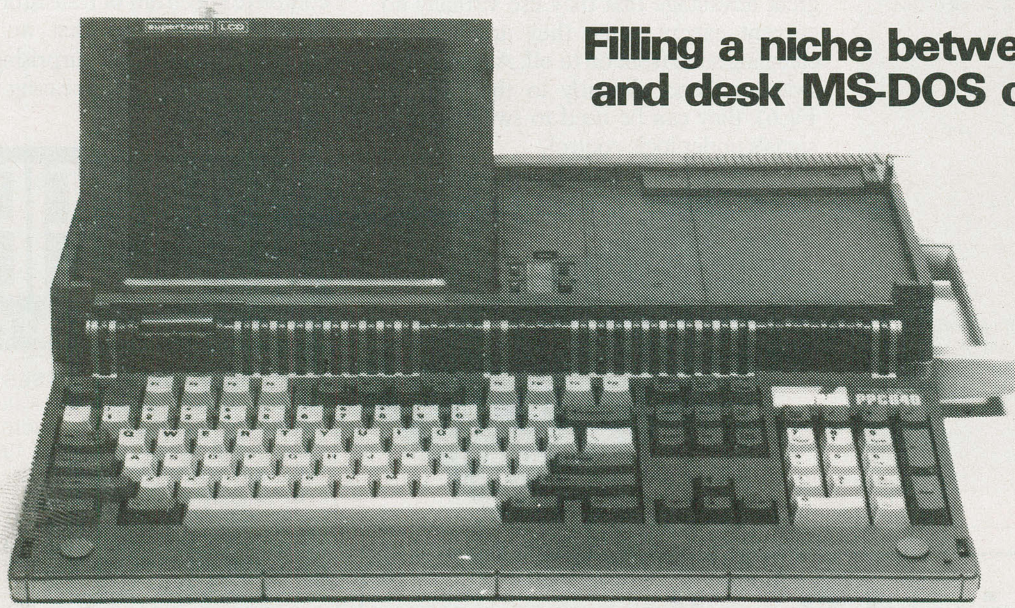
Amstrad PPC640 Portable



Filling a niche between laptops and desk MS-DOS computers.

BILL MARKWICK

The Amstrad PPC640 is a 640K MS-DOS computer that combines portability with a full complement of features, including a full-sized AT-style enhanced keyboard. Though people tend to refer to it as a laptop, with a fully-open size of about 18 inches square it's only for rather large laps. Its 80-column screen, internal modem and communications software make it very useful for travellers who need to use spreadsheets, databases, etc.

Unpacking

The computer is largely self-contained, with a top that folds down to become the full-sized keyboard. Those who've cut their teeth on the PC/XT keyboard will forever question the reason that IBM shuffled some of the keys around, in particular the Control/Caps Lock keys. However, it has a nice feel to it, and having cursor keys separate from the numeric pad is a nice touch.

Under the keyboard is a liquid-crystal display that's roughly 6 by 5 inches. It hinges upward toward the user, allowing a fair amount of adjustment, and it also includes a contrast control that can be set to compensate for the lighting angle. This lighting angle is quite important; despite its high resolution (80-column text, CGA graphics), the display is not backlit and requires careful angling to get the clearest readout. I found that the best results were from soft light coming over your shoulder. There's also an output for regular monitors, plus Amstrad's unique connector for Amstrad-only monitors; in this case, the monitor itself supplies power to the PPC.

The PPC640 is powered by 10 alkaline C cells; rechargeable NiCads are not recommended because their 1.2 volts per cell will cause a premature battery-low indication. Included in the package is an AC adapter. The manual does not give any indication of battery life, though it's obviously affected by how much you use the modem or disk drives. An adapter cord is included for running the computer from a car lighter socket.

There are two disk drives, both 720K 3.5" types. The software consists of MS-DOS Version 3.3, a telecommunications program, and a files utility called the PPC Organizer.

Also included in the package is a carrying case and a standard modular cord for connecting the modem to a telephone jack; a small compartment beside the LCD stores the phone cord.

Ports

Behind a fold-down rear panel is a standard telephone jack for the line, and another for a telephone set if you need one. A 25-pin connector and a 36-pin bring out the necessary buss lines for future expansion, the video appears on a 9-pin, the serial port on a male 25-pin D-type, and the parallel port on a female 25-pin D-type.

A DIP switch on the left side is used to switch the video from MDA (monochrome) to CGA (does anyone ever actually use the MDA mode?), and also switch from internal to external monitor, though this can be done from the keyboard as well.

A Tryout

After loading DOS and fiddling with the screen angle, we tried a wide variety of programs; all of them ran without a hitch. Programs with CGA graphics, such as the Flight Simulator (DOS version), were acceptable, though not up to the crispness of a proper monitor. LCDs, after all, are a concession to portability.

The processor, which the Norton Utilities revealed to be a NEC V20, put in an impressive performance: it rated 4.0 on Norton's SI (four times as fast as a 4.77MHz PC/XT) and 2.9 on the Bench1 program. The difference is related to the caching method used by the V20; the increase in performance depends on what type of instructions it's executing — simple

programs like word processors gain very little, complex programs gain a lot. In any case, the PPC640 doesn't lack for processing speed.

In the past, LCDs have been noted for pokey performance, but the supertwist model in the PPC zips along, rating a 55 in our Zenotest benchmark (a standard 4.77MHz with a CGA rates about 160, or one- third as fast).

The disks are typical of all 3.5" drives in being somewhat slower than the 5.25" types, but users will welcome the 720K storage space. Amstrad does not have an internal hard drive, but one will be available from third party suppliers.

Included Software

The PPC Organizer is a combination word processor, database, diary, and calculator. There's even a function for dialing the modem using either an entered number or one called from the cardfile (database). The Organizer can be run from a disk or installed as a memory-resident program. It uses a windowing system to run simultaneous functions or menus.

The Organizer has the habit of saving to the A: drive every 60 seconds, creating a disk file whether you want one or not. This may be good for the inexperienced user, but you may want to increase the delay to its maximum.

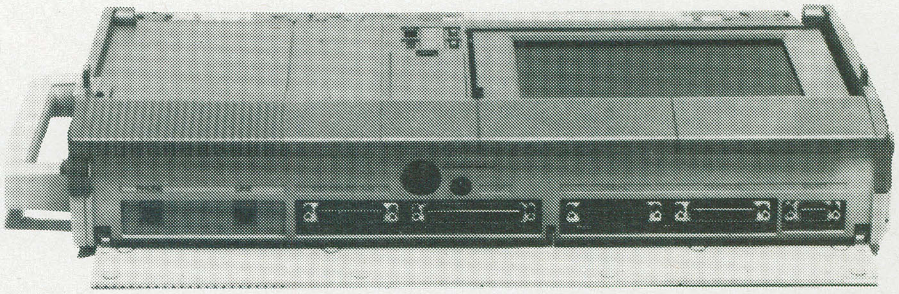
I found that the Organizer was a bit difficult to learn, though it certainly did lots of things that would otherwise require multiple programs. It takes up about 250K of disk space.

The Mirror II telecommunications program is a large, comprehensive application for doing just about every fancy file- handling trick in the book. Fortunately, its most-used functions, such as Send A File or Receive A File, are easy to access and use. The expert will find controls for just about every possible parameter.

Lastly

The included manuals are stuffed with information, but may overwhelm the beginner because of their lack of organization, which I suppose is true of most manuals. The liquid-crystal display, while adequate for a portable, may not suit you if you want the PPC640 as your only computer; check it out first by running a program that includes graphics.

The PPC640 is available from local Amstrad dealers; no doubt they will discount well below the suggested retail price of $2099. If you can't locate one, the Canadian distributor is AudioVideo Specialists Inc., 2134 Trans Canada Hwy. S., Montreal, Quebec H9P 2N4, (514) 683-5307. ■



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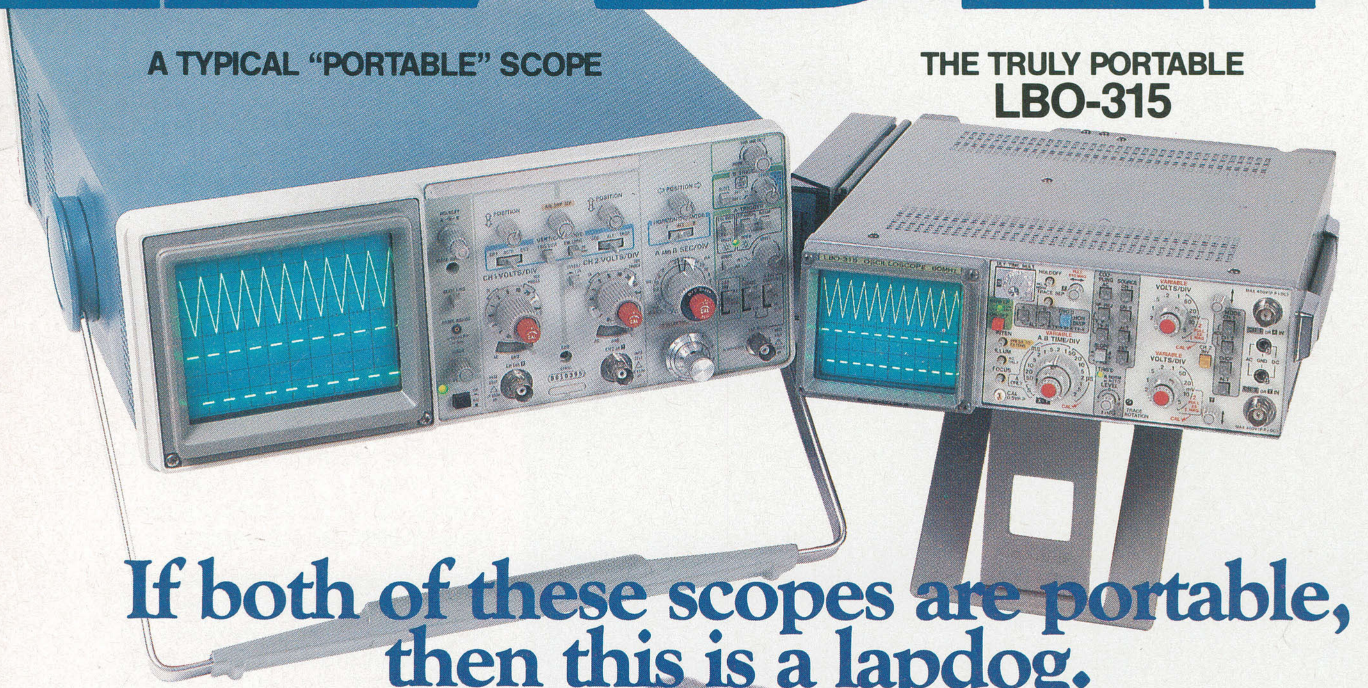

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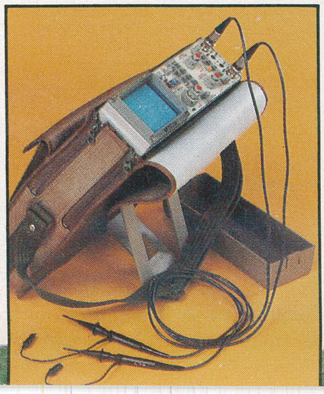

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